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OF

THE ERYSIPHACEAE

BY

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INTRODUCTION

The *Erysiphaceae* are popularly known in different countries as "White" or "Powdery Mildews," "Blight," Mehlthau, Blanc, Honungs-dagg, etc. Throughout the summer they are conspicuous in their "*Oidium*," or conidial stage on many common plants, *e. g.*, roses, hops, vines, peas, maples, *Plantago*, *Heracleum*, *Polygonum*, *Spiraea*, *Corylus*, *Quercus*, *Crataegus*, etc., and give to the infected parts of the host-plant a whitish mealy or dusty appearance due partly to the white web-like mycelium, and partly to the presence of myriads of rapidly-formed white conidia.

Later in the summer, and in autumn, the ascigerous form of fruit is produced in the shape of small, more or less globular, dark brown or black perithecia, usually provided with special outgrowths termed appendages. After producing these the mycelium often dies away, and the perithecia are left as small, blackish, globular bodies on the surface of the leaves and stems of the host-plant. Sometimes, however, the mycelium is thick and persistent, and the perithecia are then found more or less immersed in it.

The *Erysiphaceae* are characterized by the truly parasitic habit, the white mycelium, the production of large, colorless (or white) non-septate conidia on simple, erect conidiophores (forming the *Oidium* stage), and the indehiscent perithecia, or cleistocarps (mostly provided with appendages of a very definite form), containing non-septate ascospores. The family thus limited contains the genera *Podosphaera*, *Sphaerotheca*, *Uncinula*, *Microsphaera*, *Erysiphe*, and *Phyllactinia*.

The limitation of the Family *Erysiphaceae* to these six genera is not in universal use. Saccardo in the "Sylloge" (307)* divides the family into two sections: *Amerosporae*, with the characters "sporidiis ovoideis continuis hyalinis" contains the above six genera; the other, *Dictyosporae*, "sporidiis clathrato-septatis" includes the single genus *Saccardia*. Saccardo has, however, in a later work (313) excluded *Saccardia* from the family. Karsten (196) creates the sub-family "*Erysipheae* Karst." to include as well the genera *Capnodium*, *Perisporium*, *Anixia*, and *Eurotium*. Schroeter (319) includes in the family *Apiosporium* and *Lasiobotrys*, and Jaczewski (176) *Eurotium*, *Apiosporium*, *Dimerosporium*, and *Microthyrium*.

The muriform spores of *Saccardia* seem sufficient to place this genus outside the *Erysiphaceae; Apiosporium*, *Dimerosporium*, *Lasiobotrys*, and *Capnodium* differ in the black mycelium, etc.; *Eurotium* and *Anixia* are saprophytic; *Perisporium* has septate spores, and *Microthyrium* is far removed in the scutiform, not cleistocarpous perithecia. All these genera, also differ in not possessing the "*Oidium*" form of conidia.

The *Erysiphaceae* belong to the Order *Perisporiales* of the Class *Ascomycetes*. In the same order is the Family *Perisporiaceae*, to which the *Erysiphaceae* show nearest relationship. The closed perithecium, or cleistothecium, as it is sometimes termed, of the present family, must be considered as showing a low degree of development, and places the *Erysiphaceae* (together with the *Perisporiaceae*) among the simplest forms of the *Ascomycetes*. The characteristic feature of the *Erysiphaceae* is their true parasitism: the small size of the perithecia, and the abundant formation of conidia, capable of quickly infecting new hosts, must perhaps be considered rather as being adaptations to this mode of life than as primitive characters. Too much significance must not be attached to the presence of appendages to the perithecia. These appendages are strictly homologous to the mycelial outgrowths from the external cells at the base of the perithecium which occur in many genera of the *Ascomycetes*. In the Family *Ascobolaceae* of the Order *Pezizales* these outgrowths (called collectively the "secondary mycelium" by Woronin) re-

* The numbers refer to the Bibliography given at the end of the volume.—ED.

call at once the appendages of some species of *Erysiphe* (see Woronin, Beitr. Morph. Phys. Pilz. **2**: 3, *pl. 2. f. 7, 8*). We must remember, too, that in *Erysiphe* and *Sphaerotheca* the appendages are often obsolete. The function of this "secondary mycelium" is, generally, to secure the attachment of the perithecium to the substratum; in the *Erysiphaceae* the outgrowths have apparently been specially modified for purposes of distribution.

Harper (161) has some interesting remarks on the subject of the relationship of the *Erysiphaceae.*

Morphology and Life-History.

The ordinary vegetative mycelium consists of very numerous, delicate, white or colorless septate hyphae, frequently branched and more or less densely interwoven. The septa divide the hyphae into rather long cells, which according to Harper (161) contain, as a rule, only one nucleus, although cases where two to four nuclei occur are not uncommon. In all the genera except *Phyllactinia*, the hyphae of the vegetative mycelium produce haustoria at intervals which pierce the cuticle and swell out into a bladder-like form in the epidermal cells. These haustoria serve both to attach the fungus to its host and to draw nourishment from it. The haustorium is very narrow at the point where it pierces the cell-wall, and is frequently, at its entrance into the interior of the epidermal cell, surrounded by a sheath-like process proceeding from the cell-wall (see Fig. 155). According to Harper (161) each haustorium contains a single nucleus, situated towards the end, or in the middle of the bladder-like swelling or sac. This sac applies itself closely to the nucleus of the epidermal cell, and at length is completely surrounded by this nucleus, which gradually becomes disorganized, forming a thick granular coat round the haustorium. Finally, the whole of the protoplasmic content of the host cell becomes disorganized. The haustoria originate from the mycelium in three different ways; they may spring direct from the under surface of a hypha at a point where it is closely applied to the surface of the host plant, and at once pierce the cuticle. These are termed *haustoria exappendiculata;* or at certain places, at the side of the hypha, flattened semicircular processes appear, usually small, not exceeding in width the diameter of the hypha, and from the under sur-

face of these (which are closely appressed to the cuticle), or from the hypha itself at the point where the swelling originates, the haustoria are produced in the usual manner—these are termed *haustoria appendiculata ;* or, finally, the hyphae are sometimes provided with processes, often on both sides at the same point, which are more or less deeply lobed or crenulate at the margin, or reniform in shape, and from these swellings, or from the hypha itself adjacent to them, the haustorium proceeds—these are *haustoria lobulata* (Fig. 128).

The genus *Phyllactinia* shows some important differences in the manner of producing haustoria. As pointed out by Palla (264), in his valuable paper, the vegetative mycelium on the under surface of the host-leaf does not send haustoria into the epidermal cells, but forms special hyphal branches, of limited growth, which enter the stomata, penetrate into the intercellular spaces, and finally send haustoria into the surrounding cells of the spongy-parenchyma (Fig. 163). Each of these special branches, or "Ernährungshyphe," consists of two, three, or rarely more cells, and is sometimes sufficiently long to extend through the spongy-parenchyma to the palisade-cells, but no haustorium has been observed to be formed in the cells of this layer. Each "Ernährungshyphe," of which sometimes two pass through the same stoma, produces a single haustorium, in all cases, from its last cell. Sometimes two haustoria (produced by different hyphae) are found in one cell. The haustorium itself does not differ from that found in the other genera of the *Erysiphaceae*.

With the exception of the haustoria, and the special branches of *Phyllactinia*, the mycelium of the *Erysiphaceae* is entirely superficial, *i. e.*, external to the tissues of the host-plant. In the rose mildew, *Sphaerotheca pannosa*, it has been frequently stated that the mycelium hibernates during the winter months within the tissues of the host-plant, but this statement appears to rest merely on supposition.

The first kind of reproductive bodies borne by the mycelium are the asexually-produced conidia, which are formed under favorable circumstances, throughout the summer and during the early part of autumn. The mycelium produces special hyphal branches, the conidiophores, which are erect, simple, colorless or white, thin-

walled, one-to-many septate, about 10 μ thick, and from 110 to 380 μ high. From these the conidia are formed by abstriction, either singly at the apex or in long chains in basipetal succession. The conidia are continuous, *i. e.*, non-septate, colorless or white, oblong, cylindrical, or barrel-shaped, smooth, thin-walled, and from 20–50 × 10–24 μ in size. Harper (161, p. 664) states that a single nucleus passes from the parent-hypha into the young conidiophore, and that from it arise the nuclei of all the conidia subsequently formed.

Conidial forms of the *Erysiphaceae* were formerly classified as an autonomous genus of the *Hyphomycetes* under the name of *Oidium*. It soon became observed, however, that the *Oidium* was frequently succeeded by species of the *Erysiphaceae*, or that the *Oidium* even occurred among the perithecia of the latter. Berkeley in 1841 (26, see also 29) was among the first to give conclusive evidence of the organic connection of the *Oidium* with the *Erysiphaceae*. It is now well known that during the stage in which the conidial form is just passing over into the perithecial, conidiophores and perithecia may frequently be observed in organic connection.

The conidia are usually formed in immense numbers throughout the summer, and being easily carried by the wind, are the means of rapidly spreading the fungus during the growing season. It may be noted that Wagner (380) observed in several instances the distribution of conidia effected by snails, and mentions that the conidia of *Erysiphe polygoni* on plants of *Hypericum* by this means were carried to plants of *Aquilegia*, and those of *Sphaerotheca Castagnei* on *Impatiens* to other plants (see also Stevens (340*)).

The conidia are capable of immediate germination on reaching the epidermis of a suitable host-plant. Even in a dry atmosphere, but more readily in a damp one, or in water, one or more delicate germinal tubes are produced near one end of the conidium. Soon the first haustorium is formed (sometimes immediately on germination), and from this center hyphae grow out, branching, crossing, and developing haustoria. The vegetative mycelium thus formed continues to develop, and under favorable conditions begins to produce conidia in a few days.*

* Dangeard (96) has observed cases of conidiophores being produced direct from the germinating conidium.

The second phase in the life-history of the *Erysiphaceae* occurs later in the summer, or in autumn, usually when the vitality of the host-plant begins to diminish. The formation of conidia is then gradually superseded by that of perithecia, containing ascospores, or resting-spores, whose function is to carry the fungus in a dormant condition through the winter, when host-plants are not available.

The history of the development of the perithecium was first investigated by de Bary (98 and 99). At the crossing point of two hyphae, or at the place where two neighboring hyphae touch, each develops a small upright branch, which is soon cut off by a septum from the parent hypha. One of these branches swells to an oval-oblong shape, and becomes the oögonium. The other lengthens slightly, and applies itself closely to the side of the oögonium, curving above so that its end lies on the apex. The uppermost part is then cut off by a septum, and forms the antheridium.

De Bary observed no breaking down of the wall between the antheridium and the oögonium, and so supposed that no conjugation took place, but nevertheless considered that these organs represented a true sexual apparatus, and that the perithecium subsequently formed was to be regarded as the result of a sexual act. This last conclusion has lately been strikingly verified by the work of Harper. The following details are taken from the two important papers of this author (160 and 161).

The oögonium and antheridium each contain a single nucleus. At the time of fertilization the cell-wall between the two organs is dissolved, and the nucleus of the antheridium enters the oögonium, and unites with its nucleus. At this point the protoplasm of the antheridium is in direct contact with that of the oögonium; soon, however, after the passing over of the nucleus of the antheridium into the oögonium, a fresh wall is formed between the two organs, and then only a small quantity of protoplasm is found in the antheridium. At the time when the union of the two nuclei takes place, the development of the walls of the future perithecium begins. From the stalk cell of the oögonium a number of hyphal branches spring, closely pressed side by side, and grow upwards, forming a single layer round the oögonium. The stalk cell of the

oögonium then swells to a circular shape, and a second series of hyphae, internal to the first, grow up in a similar manner. The hyphae of both series branch and intertwine, completely growing together, and forming finally a pseudo-parenchymatous tissue. A number of branches grow from the internal layers of this primary coat towards the interior of the developing perithecium and, repeatedly branching, fill up all interstices. The cells of these branches, which are very rich in protoplasm and contain several nuclei, disappear in the course of the growth of the perithecium, becoming absorbed by the developing ascus or asci. The cells of the outer layers become greatly flattened, and lose their protoplasmic contents, the external ones becoming dark brown and forming the outermost wall of the perithecium.

The oögonium after fertilization is known as the carpogonium, and undergoes certain changes, which vary slightly according as one or several asci are formed.

In *Sphaerotheca*, where a single ascus is found, the following growth takes place. At about the time when the two primary layers of hyphae have grown up from the stalk-cell, the carpogonium begins to elongate, and nuclear division takes place, resulting in the formation of a single, more or less curved row of five or six cells. In the penultimate cell of this row two large nuclei are always present, while the other cells contain only one each. This penultimate cell is the young ascus. It swells strongly, so that the apical cell of the series is pushed aside and downwards, and finally absorbed. The two nuclei now fuse, and the ascus rapidly increases in size, pressing together and flattening the cells of the inner layers of the young perithecium. The nucleus increases in size, and finally divides three times, providing the nuclei for the eight ascospores which are subsequently produced by free-cell formation. In *Erysiphe*, where several asci are produced in the perithecium, the development is, with slight modifications, the same as that of *Sphaerotheca* (see Harper (161)).

The fusion of the nuclei in the young ascus is evidently to be regarded as a vegetative one, similar to that which occurs in basidia, cystidia, and the asci of the other fungi—even sometimes, according to Massee (240), in the hairs of some of the *Discomycetes*. Dangeard (96) however, regards the fusion of

nuclei in the young ascus as of sexual significance, and denies the primary sexual fusion of the nuclei of the oögonium and antheridium; but, as Wagner (379*) points out, the weight of evidence is against accepting Dangeard's theory.

When the perithecia are about half-grown, certain cells of the outer wall, situated either apically, equatorially, or basally begin to grow out into the appendages. These appendages, if basal, may be floccose and more or less similar to the hyphae of the mycelium, with which, as in the genus *Erysiphe*, they are frequently interwoven; usually, however, they are quite distinct from the myselium, erect or radiating, and sharply characterized in shape. In *Phyllactinia* they are acicular and bulbous at the base (figs. 170, 171); in *Uncinula* hooked at the apex (see Plates 4 and 5), and in *Podosphaera* and *Microsphaera* they are variously branched in a dichotomous manner (see Plates 1 and 2).

It is difficult to say definitely what part the appendages play in the life-history of the *Erysiphaceae*, although it is generally supposed that they are concerned with the distribution of the perithecia (see Gardner, 142).

The perithecium of *Phyllactinia*, besides the acicular appendages, possesses a basal mass of special branched hyphae, which certainly serve in the first place to attach the perithecium to the leaf, and in some cases, perhaps many, causes it subsequently to adhere to foreign substances.

The asci contained in the perithecia are colorless sacs, stalked or sessile, globose to cylindrical in shape, and from one to 66 (or more) in number. They contain from two (or abnormally only one) to eight spores. The wall of the ascus is from 1–5 μ thick, and usually becomes very thin at the apex of the ascus. No true paraphyses are present, although this name has been given by some authors to the isolated portions of the inner wall, often of a filiform shape which sometimes occurs in the perithecia (especially in *Phyllactinia*).

The ascopores are colorless, continuous (*i. e.*, non-septate), granular, oval, oblong, or occasionally roundish, with obtuse ends, rarely slightly curved, 15–34 (rarely reaching 50) $\times$ 8–25 μ in size.

The perithecia are truly cleistocarpous, the asci being liberated by the irregular rupture of the wall. This takes place in the

spring following the season in which the perithecia were produced. In some cases, as in *Erysiphe galeopsidis*, and, as a rule, in *E. graminis*, the ascospores are not formed until the following spring, the protoplasm of the asci remaining throughout the winter in a granular condition. It appears that the ascospores are incapable of immediate germination, and require to pass through a resting stage, lasting the winter months. Galloway (139) and also Worthington G. Smith (329) state that in the spring the perithecia, under favorable conditions, suddenly burst and forcibly eject the asci. Harper (161, p. 663) mentions that the cells of the inner wall of the perithecium permanently retain their nuclei and protoplasmic contents, and suggests that they may produce a substance capable of swelling in water, and so causing the rupture of the perithecium.

The ascospores in a damp atmosphere or in water send out in a few hours germ tubes, which (according to Wolff) on reaching the epidermis of a suitable host-plant penetrate and form a haustorium, from which center the ordinary vegetative mycelium is produced. Very little, however, is known on the subject, and no records exist, apparently, of any artificial infection of host-plants by means of ascospores. Galloway (139) has made some valuable observations on the ripening and germination of the ascospores in *Uncinula necator* and Wolff (398, 399) in the case of *Erysiphe graminis*, and Tulasne has recorded cases of the commencement of germination of the ascospores of *Phyllactinia corylea*, *Sphaerotheca pannosa* and *Erysiphe tortilis*.

With the formation of perithecia the mycelium frequently entirely disappears. Sometimes, however, as in *Sphaerotheca pannosa* and *Erysiphe graminis*, it is persistent, and produces special branches in the form of long, branched, interlaced, shining, thick-walled hyphae, in which the perithecia are more or less immersed. It has been stated that in certain species, viz, *Sphaerotheca pannosa*, *Podosphaera oxyacanthae*, *P. leucotricha* and *Uncinula necator*, the mycelium is perennial, passing the winter months in a state of hibernation; definite proof of this, however, has not been given in any case.

It is sometimes found that perithecia, which externally present the normal appearance, instead of containing asci, emit when opened

a stream of very small, biguttulate spores, 6.5–10.5 × 3.5–6μ in size, immersed in a colorless mucilaginous substance. In such cases there may usually be found on the same mycelium paler and smaller bodies, globular, oval, or pyriform in shape, without appendages, and containing the same kind of spores. Similar bodies are frequently formed in the joints of the conidiophores when they usually bear at their apex the shrivelled remains of the chain of conidia.

Prior to De Bary's searching investigations into this subject in 1870 (99), these bodies were known as pycnidia, and the contained spores as stylospores, and by the older botanists were thought to be another form of reproduction of the *Erysiphaceae.* De Bary, however, showed that the pycnidia and spores belonged to a minute fungus living parasitically within the hyphae of species of the *Erysiphaceae.* The vegetative mycelium of this parasitic fungus (*Ampelomyces quisqualis*) is composed of a great number of closely septate hyphae, which run singly inside the hyphae of the host. The fruit of the *Ampelomyces* is produced either in the perithecia, conidiophores, or cells of the host mycelium. If the species attacked is in the perithecial stage, the parasite forms its fruit in the interior of the perithecium, absorbing the asci and sometimes sending its hyphae into the appendages. The variation in shape of the pycnidia is due to the difference in the maturity of the perithecia attacked. If the host is in the conidial condition, the fruit of the *Ampelomyces* is produced in the transformed cells of the conidiophores, and in this case the presence of the parasite seems to prevent any subsequent formation of perithecia.

De Bary succeeded in infecting germinating conidia of species of the *Erysiphaceae* with the spores of *Ampelomyces*, and found that the latter on germination at once penetrated the germinal hyphae of the conidia. In some cases, the spores of the *Ampelomyces* germinated after they had been kept for three months in a dried condition. They are, therefore, probably capable of infecting fresh hosts after passing through the winter in a resting state. *Ampelomyces* has been observed on most of the species of the *Erysiphaceae*, and no doubt plays an important part in checking their spread, by lessening their vitality, and often preventing the formation of perithecia (see Griffiths, 153, pp. 184, 185).

In the *Erysiphaceae*, as in other groups of parasitic fungi, we find that in some years, from unknown causes, the species attack certain host plants in a marked manner. This is well illustrated by the wave of disease, caused by *Sphaerotheca humuli*, which periodically sweeps over the cultivated hop, and in the attacks, by the same fungus, in certain years on cultivated strawberries; and it is not the less noticeable with regard to wild host-plants. Some interesting biological notes, on this and other points, are given by Griffiths, in his paper on "Some Northwestern *Erysiphaceae*" (152).

The frequency with which great devastation is caused by members of the present family to cultivated plants of high economic value makes the study of their life history a matter of importance. The two worst diseases are those caused by the vine and hop mildews (*Uncinula necator* and *Sphaerotheca humuli*), which at certain periods have caused wholesale destruction to the cultivated vines and hops of the world. Other well-known diseases are caused by the rose mildew (*Sphaerotheca pannosa*), the apple mildew (*Podosphaera leucotricha*) and the pear and cherry mildew (*P. oxyacanthae*), the gooseberry mildew of America (*Sphaerotheca mors-uvae*) and the gooseberry mildew of Europe (*Microsphaera grossulariae*), the pea, bean and turnip mildew (*Erysiphe polygoni*), and the corn mildew (*E. graminis*).

All these diseases, it is now proved, are able to be held in check by the prompt use of certain fungicides. I have endeavored to give full instructions for the preparation and use of the best remedies under each species of mildew causing a disease.

HISTORICAL

Linnaeus in the *Species Plantarum* (1753) mentioned a fungus under the name of *Mucor Erysiphe*—"Mucor albus, capitulis fuscis sessilibus. Habitat in foliis *Humuli, Aceris, Lamii, Galeopsidis, Lithospermi*." By this name the four species of the *Erysiphaceae* now known as *Sphaerotheca humuli*, *Uncinula aceris*, *Erysiphe galeopsidis* (on *Lamium* and *Galeopsis*) and *E. cichoracearum* were in all probability intended. In 1767, in the "Mundus Invisibilis" (222) Linnaeus spoke of *Erysiphe* as a genus (giving, however, no strict definition). Persoon, in 1796 (Obs. Myc. **1**: 13), gave the

name *Sclerotium Erysiphe* to Linnaeus' species, and in 1801 (Syn. Meth. Fung. **1**: 124) separated the plant on *Corylus* as var. *β corylea* (= *Phyllactinia corylea*).

In 1804, in a work by Rebentisch (295) we meet with the first illustration. The fungus was called *Sclerotium suffultum*, and represents the species now known as *Phyllactinia corylea*.

In 1805 De Candolle (62) published the mss. genus "*Erysiphe* Hedw. f.," and very briefly described, often under several different names depending on the host-plant, the species now known as *Phyllactinia corylea*, *Uncinula salicis*, *Erysiphe polygoni*, *E. cichoracearum*, and *Microsphaera berberidis*. De Candolle in 1806, in the Syn. Pl. Gall. added *Erysiphe aceris* (= *Uncinula aceris*); in 1807 (64) *E. oxyacanthae* (= *Podosphaera oxyacanthae*), and in 1815, in vol. 6 of the Flore Française the species now called *Microsphaera euonymi*, *M. astragali*, *M. alni* var. *lonicerae*, *Sphaerotheca humuli*, *Uncinula prunastri*, *Erysiphe graminis* and *E. galeopsidis*.

In 1815, also, Bivoni Bernardi (41) described and figured *Erysiphe vagans* (= *Phyllactinia corylea*) and *E. clandestina* (= *Uncinula clandestina*). The figures of both are good, and in that of the latter species the uncinate apex of the appendages is carefully shown.

In the same year Fries in Obs. Myc. p. 206, united all the hitherto described species under the name of *Erysiphe varium*.

The alteration of the spelling of the genus to "*Erysibe*" originated with Nees von Esenbeck, in 1817 (257), who used the name "*Erysibe suffultum* Rebent." for the *Erysiphe suffultum* of that author, and subsequent authors followed in attributing the word "*Erysibe*" to Rebentisch.

In 1819 the most important of the early works on the *Erysiphaceae* appeared. These were Wallroth's two papers, one entitled "Naturgeschichte des *Mucor Erysiphe*," in the Berlin Gesell. Nat. Freunde Verhandl. **1**: 6–45; the other, called "De *Mucore Erysiphe* Linnaei observationes," in the Annal. Wett. Gesell. **4**: 226–247.

Through Wallroth's work an important addition was made to the existing knowledge of the family. It may be said that in all works prior to this date the host-plant on which the *Erysiphe* grew afforded the chief specific character. Wallroth pointed out that the same species often grew on a great number of different host-

plants and insisted on the need of each species being defined by morphological characters. Attention was also directed to the value of the appendages as affording diagnostic characters, and the various shapes and mode of branching shown by these organs were carefully noted.

With respect to nomenclature, Wallroth made some unfortunate changes. Regarding the name *Erysiphe* as unsuitable (on account of its derivation from the Greek word ’ερυσίβη, which is stated to have meant *robigo*, or rust), Wallroth proposed *Alphitomorpha* in its place, and used the name *Erysibe* to supersede the genera *Uredo*, *Ustilago*, etc. These changes, however, were not adopted by subsequent authors, and it need only be mentioned that in accordance with the laws of botanical nomenclature, Wallroth's reasons for overthrowing the name *Erysiphe* for the present group are insufficient.

An appendix by Schlechtendal immediately followed Wallroth's paper in the Berlin Verhandl. This work is especially interesting from the fact that it is here for the first time clearly recognized that the *Erysiphaceae* may be divided into two groups, one in which the perithecia contain a single ascus with eight spores, the other in which these contain several asci. This important fundamental difference is well shown in a figure.

From 1819 until 1851 little advance was made.

In 1823 Kunze (208) founded the genus *Podosphaera* for the "*Sphaeria myrtillina*" of Schubert, and gave good figures illustrating the characters of the genus.

Link, in 1824, in Willdenow's "Species Plantarum," arranged the species described up to that time in two sections, "sporangiolo unico," and "sporangiolis pluribus."

In 1825–27 Greville, in the Scottish Cryptogamic Flora, described and figured *Erysiphe pisi* (= *E. polygoni*), *E. adunca* (= *Uncinula salicis*), and *Eurotium rosarum* (= *Sphaerotheca pannosa*).

Perhaps the most important works about this time were Fries' Syst. Myc. (1829), Duby's Botanicon Gallicum (1830), and Wallroth's Fl. Crypt. Germ. (1833), although they added but little to the existing knowledge of the *Erysiphaceae*.

In 1834 Schweinitz (322) published an account of the North American forms, in which sixteen new species were described;

many of these, however, were the same species on different host plants.

In 1838 Corda (92) figured *Erysiphe Perisporium* (= *E. polygoni*) and *E. bicornis* (= *Uncinula aceris*).

During 1846–9, Durieu and Montagne (109) described several species from Algeria.

In 1851 Léveillé published in the Ann. Sci. Nat., his classical monograph entitled "Organisation et Disposition méthodique des espèces qui composent le genre Érysiphé." In this work after dividing the *Erysiphaceae* into two sections, "Sporangium unicum" and "Sporangia plurima," Léveillé arranged the species in five genera, viz, *Podosphaera* Kze. and *Sphaerotheca* Lév. belonging to the first section, and *Phyllactinia* Lév., *Uncinula* Lév., *Calocladia* Lév. (afterwards changed to *Microsphaera* (see *l. c.*, 381) and *Erysiphe* Hedw. f. DC. (emend.) belonging to the second.

These genera, based on characters shown by the appendages, are still found to embrace all the known species of the *Erysiphaceae.* For establishing these extremely natural genera, and for the broad view shown in the treatment of species, Léveillé's work has long been recognized as of the highest value.

In 1861 the brothers Tulasne described fully and illustrated sixteen species of the *Erysiphaceae* in the first volume of the Selecta Fungorum Carpologia. The five plates, engraved on copper, contain the most beautiful illustrations of the family existing, and show well the stages in the life-history of both the conidial and perithecial form. The genera established by Léveillé are not kept up, the species all being referred back to the old genus *Erysiphe.*

In 1870 De Bary's great work on *Erysiphe* in the "Beiträge zur Morphologie und Physiologie der Pilze" appeared. Here the general life history of the *Erysiphaceae*, and especially the history of the development of the perithecia, were minutely investigated. In a systematic appendix De Bary divided the family into two genera—*Podosphaera*, with the characters "carpogonia orthotropa. Ascus in quoque perithecio unicus (rarissime, lusu, 2), octosporus; and *Erysiphe*, "carpogonium campylotropum. Asci in quoque perithecio 4 aut plures."

In 1872 Cooke and Peck published their papers (90 and 91) on

the *Erysiphaceae* of the United States, describing a number of new species.

Karsten (1873) in Myc. Fenn. (192) and, later (1885) in the Act. Soc. Faun. Fl. Fenn. (196) described the *Erysiphaceae* of Finland, and in 1884 Winter monographed those of Germany in Rabenhorst's Krypt. Fl. Deutschl. (394).

In 1887 the important work entitled the "Parasitic Fungi of Illinois, Part 2, *Erysipheae*" by Burrill and Earle appeared. It would be difficult to praise this work too highly for the clear descriptions of the species (28 in number), the careful enumeration of the host-plants, and especially for the broad view shown in the conception of what constitutes a natural species. Burrill's excellent account of the North American species in Ellis and Everhart's N. Amer. Pyrenomycetes (1892) is based on the above work, and contains some important additions.

In 1893 Schroeter enumerated the *Erysiphaceae* in Cohn's Krypt. Fl. von Schlesien, in 1896, Jaczewski published his "Monographie des Erysiphées de la Suisse" (176), and in 1897 Oudemans described the species found in the Netherlands (263).

In 1895 Harper's valuable work (160) on the history of the development of the perithecium appeared.

At the beginning of 1899 Palla published his important paper "Ueber die Gattung *Phyllactinia*." It is here pointed out that *Phyllactinia* differs from the other genera in producing its haustoria from hyphae sent through the stomata of the host-leaf. As a result of this interesting discovery, the *Erysiphaceae* are now divided into two sub-families, the *Erysipheae* and the *Phyllactineae*.

In Saccardo's "Sylloge Fungorum" (1882–1899) an enumeration of all the published species of the *Erysiphaceae* is given. Meschinelli (248), in his work on fossil Fungi, describes and figures a genus *Erysiphites*, with one species (= *Erysiphe protogaea* Schmalh.) found on *Ficus kiewiensis* in one of the Tertiary formations in Russia.

GENERAL REMARKS ON THE CONNECTION BETWEEN HOST AND PARASITE

In the *Erysiphaceae*, perhaps as much as in any group of fungi there has been, especially in the past, an undue multi-

plication of species. For example, more than twenty forms of *Phyllactinia corylea* (notwithstanding that this is the most sharply characterized species in the family) have been published as new species. For the most part, these "species" were supposed to be confined to the host-plant on which they were discovered, and after which they were named; this was the case with *Erysiphe fraxini*, *E. betulae*, *E. alni*, *E. mali*, *E. fagi*, *E. quercus*, *E. pyri*, *E. ilicis*, *E. cerasi*, etc.

It is interesting to note that even among the earlier authors this unscientific practice of making a new species of a form because it occurred on a new host-plant did not pass unreproved. As early as 1819 Wallroth (383, p. 18) says: "Es ist ein ganz irriger Glaube und ein unverzeihlicher Fehler der Flüchtigkeit, wenn wir * * * so viel Arten der Epiphyten aufgestellt und nach den Pflanzen selbst, auf denen sie hervorbrechen, benennt finden als deren selbst sind." Again, in 1851, when Léveillé arranged in clearly defined species the great mass of named forms (often distinguished merely by the host on which they grew) which had accumulated since Wallroth's time, the same warning is repeated; "Pour les reconnaître on devra les étudier seulement quand ils auront atteint leur plus haut degré d'organisation et ne plus faire attention aux végetaux sur lesquels on les rencontre. Cette manière de les dénommer est essentiellement vicieuse, elle conduit à la confusion et à l'erreur."

In Saccardo's "Sylloge" 111 species, and 1 variety, and 20 species "dubiae vel inquirendae," are enumerated. To this number must be added 8 species and 6 varieties, either accidentally omitted from the Sylloge, or published subsequently.

In the treatment of the family in the present paper 49 species and 11 varieties are recognized. Of these three species and two varieties are new to science.

This great reduction of species will not be wholly unexpected, as a similar process has been found necessary in the treatment of the family by several authors, in works published subsequently to the "Sylloge." Winter, for instance, in his work on the *Erysiphaceae* of Germany, reduced several of the European species enumerated in the "Sylloge," and in 1887 Burrill and Earle (61) similarly accounted for many of the American species of Schweinitz,

as well as for several of those described by later American authors.

The further reduction of species that has been made in the present work may be ascribed mainly to two causes: (1) The necessity of adopting a wide view of a species when dealing with material from all parts of the world; and (2) The adoption of the principle that classification must be based primarily on morphological characters.

As a necessary consequence of adherence to the latter view, the connection of a parasitic fungus with a certain host-plant cannot be considered as affording a character of specific importance. If it were to be proved that two forms of a fungus, morphologically indistinguishable from one another, occurring on different species of host plants, were incapable of infecting any but their respective hosts, then these two forms might be classified as "biological" varieties or species, and in such a case the connection between the parasite and its host would become a character of systematic importance. No such evidence, however, is at present adduced in connection with the members of the *Erysiphaceae*. For the present, therefore, to mention one example, such a species as *Sphaerotheca epilobii*, supposed to be confined to species of *Epilobium*, but morphologically indistinguishable from certain forms of the polymorphic *S. humuli*, cannot be maintained.

The question of the systematic value of the connection between host and parasite is one of great importance. The connection is frequently treated as affording a character of primary specific importance, and it will, perhaps, not be out of place here to utter a protest against this practice. The method of classification commonly followed in dealing with parasitic fungi is well illustrated in the treatment the genus *Phoma* has received. Over 1,000 species are enumerated in Saccardo's "Sylloge," and the majority of these are named after the host-plant on which they occur. That the connection of parasite and host is here made the character of primary importance can be seen from the treatment of the genus given in local floras. Allescher in enumerating 570 species of *Phoma*, in Rabenhorst's Kryptogamen Flora Deutschlands, has adopted an arrangement thus described: "Die Arten der

Gattung *Phoma*, sind im Folgenden je nachdem sie auf Holzgewächsen, krautartigen Dicotyledonen, Monocotyledonen, oder Kryptogamen wachsen, und in jeder Abtheilung nach den alphabetisch geordneten Nährpflanzen angeordnet." When in place of such an arrangement as this, where the connection between host and parasite is considered of primary specific importance, and where a mere alphabetical list is substituted for a natural classification, a monograph of the genus *Phoma* appears in which the species are defined by morphological characters, a more scientific method in the classification of fungi will have commenced.

After the forms of the *Erysiphaceae* have been grouped around what may be termed "morphological centers," the next most important work is to experiment biologically with them. Such experimental work remains, unfortunately, almost entirely to be done. A few instances are on record of attempts to sow the spores of one species on the host-plants peculiar to another species, *e. g.*, the spores of *E. graminis* on the host-plants of *E. polygoni*, and those of *E. polygoni* on the vine, the host-plant of *Uncinula necator;* in all cases without success.

An experiment performed by Magnus (mentioned in detail under *Sphaerotheca*), although unfortunately incomplete, is of great interest. Conidia of *Sphaerotheca humuli* growing on the hop, were taken and sown on *Taraxacum officinale*, a common host-plant of *S. humuli* var. *fuliginea.* This variety (considered a distinct species by Burrill and most American authors) is distinguished by the much larger cells of the perithecium, usually different character of the appendages, etc. The conidia of *S. humuli* germinated on the *Taraxacum*, and produced a mycelium bearing conidia. Observations were not continued to see if perithecia would be produced. From this experiment we are led to one of three conclusions. We must suppose either : (1) That the conidia of *S. humuli* on this host would have produced ultimately the perithecia at present considered characteristic of the var. *fuliginea*, in which case we should have to consider the latter as merely a form of *S. humuli* induced by growing on certain host-plants. This view is rather favored by the fact that in some species we have certain forms associated with certain hosts which present slight morphological differences, although these are not

sufficiently marked to prevent the forms from being considered as belonging to the species. Or (2) We must suppose that the conidia of *S. humuli* on a strange host-plant, although producing a mycelium capable of giving rise to conidia, might be unable to continue its development and produce perithecia, in which case the form would quickly die out. Certain *Oidium*-forms, *e. g.*, that on species of *Myosotis*, appear seldom, if ever, to produce perithecial fruit. Finally, (3) That the conidia might have ultimately produced perithecia similar to those of ordinary *S. humuli*. This seems perhaps unlikely, when we remember that *S. humuli* has never been recorded on *Taraxacum*, notwithstanding that this plant is a common weed in many places (*e. g.*, hop-gardens) where *S. humuli* grows.

The compilation of a list of the host-plants of the *Erysiphaceae* is attended with many difficulties.

1. In the first place the fungus has frequently been wrongly determined in Exsiccati. An instance will make this clear, and illustrate how wrong plants may become recorded as hosts for certain species. In eleven examples from certain Exsiccati "*Sphaerotheca Castagnei*" is given as the species occurring on these hosts :— *Inula hirta* (Sacc. Myc. Ven. 630), *Plantago maritima* (Rab. Fung. Eur. 1916), *P. major* (Rab. Fung. Eur. 1048), *Achillea Ptarmica* (Rab. Fung. Eur. 1051), *Senecio sylvaticus* (de Thüm. Fung. Austr. 441), *Eupatorium cannabinum* (Cooke, Fung. Brit. Exsicc. ed. 2, 591, 592), *Trifolium medium* (Syd. Myc. March. 3052), *Calystegia sepium* (Syd. Myc. March. 432), *Catalpa syringaefolia* (Syd. Myc. March. 1640), *Falcaria vulgaris* (Syd. Myc. March. 1541) and *Stachys alpina* (Sacc. Myc. Ven. 1491). In the first six specimens the fungus is *Erysiphe cichoracearum*, in the next four *E. Polygoni* and in the last *E. galeopsidis*. Here we have eleven species of host-plants wrongly given for one species in specimens sent out in exsiccati. It is, moreover, probable that the error does not stop here, but that it is perpetuated by the fungus on these hosts being named and recorded as "*S. Castagnei*" without examination by subsequent collectors ; it is significant that four of the plants given above are stated to be hosts of *S. Castagnei* by several authors.

2. The list of host-plants has been further complicated by the

practice followed by many authors of determining a plant specifically in its conidial (*Oidium*) stage. As yet, we do not know enough about the conidial form (which is possibly as variable in some species as the perithecial is known to be) to be able to determine it specifically with safety, and it is certain that the practice of doing so had led to many errors. I have, therefore, as far as it has been possible, omitted in my host-index those records in which the fungus has been observed only in the conidial condition. The treatment which the fungus on *Cucurbitaceae* (*Cucumis, Cucurbita*) has received, affords evidence of the danger of naming the conidial forms. In herbaria and published records the fungus is stated almost without exception, to be *Sphaerotheca Castagnei.* Schroeter, however, having observed the perithecial stage on *Cucurbita Pepo*, has named it *Erysiphe polygoni.* In collections and exsiccati this fungus on *Cucurbitaceae* exists apparently only in the conidial stage, and the only specimen that I have seen with perithecia occurred on *Cucurbita Pepo*, in late autumn, at Reigate, Surrey, England. On this specimen the fungus is undoubtedly *Erysiphe cichoracearum*, the species recorded on *Cucurbitaceae* by American mycologists.

3. Certain common species of *Erysiphe* are, in my experience, always wrongly determined. In Europe there is a species, not uncommon on *Valeriana officinalis* which, without exception, has been referred to *E. communis* (*E. polygoni*) by authors; it is, however, undoubtedly *E. cichoracearum.* The fungus not uncommon on *Anchusa officinalis* and *Echium vulgare* has been named *E. cichoracearum*, and no records exist of *E. polygoni* occurring on these hosts, yet all the specimens I have seen in herbaria are really to be referred to the latter species. The only fungus on *Galium* that I have seen is *E. cichoracearum*, yet it is always named in European herbaria and exsiccati *E. communis* (*E. polygoni*), and is so recorded in all works.

I have thought it advisable, therefore, on account of the confusion that exists in many cases, to compile a host-index from personal observations, chiefly with the view of seeing if any facts of interest could be gained on the subject of the general relation between parasite and host. By means of the abundant material received from many parts of the world, and through the examina-

tion of the chief herbaria, I have been enabled to observe the occurrence of species of the *Erysiphaceae* on 1002 different species of host-plants.* To make the list, as far as possible, complete, I have incorporated 367 additional host-plants recorded in the literature of the subject, and have also noted all those cases in which a different species of mildew to that personally observed on any host-species has been recorded by authors. In both the latter cases the plants are distinguished in the host-index by an asterisk, and the authority for each record is indicated in the list of host-plants given under the respective species of fungus. The names of the host-plants have been, so far as possible, brought into accordance with those of the Index Kewensis.

The restriction of the parasite in its choice of host-plants varies greatly in the species of the *Erysiphaceae.* Many species, *e. g.*, *Erysiphe tortilis* on *Cornus sanguinea*, *Uncinula geniculata* on *Morus rubra*, and *Podosphaera biuncinata* on *Hamamelis Virginiana* have a more or less wide geographic distribution, and yet, so far as at present known, are absolutely confined to their respective host-plant. About as many instances occur in which the hosts of the fungus are limited to one genus ; *e. g.*, *Uncinula aceris*, its var. *Tulasnei*, and *U. circinata* are confined to species of *Acer ; U. flexuosa* to species of *Æsculus*, and *Sphaerotheca lanestris* to species of *Quercus.* A few species are limited in their choice of host-plants to certain families, *e. g.*, *Uncinula salicis* on *Salicaceae*, *Sphaerotheca pannosa* on *Rosaceae*, *Erysiphe graminis* on the *Gramineae.* Finally, many species occur on a great number of

* A word may be given here on the right manner of using the host-index. Rightly used, it affords, when the name of the host-plant is known, a useful clue toward identifying an unknown species, and in a certain sense serves as a key to all the species of the *Erysiphaceae*, wrongly used, it may easily be the means of perpetuating errors. To illustrate, if there be but one species of fungus recorded on the host-plant in hand, it is then necessary merely to turn to the description of the fungus and see if the specimens to be named agree in the characters given. The practice of naming a fungus from a host-index, without examination, cannot be too strongly condemned. If several species have been recorded on the host, the description of each must be consulted until the fungus is identified. It is, perhaps, not unnecessary to add that if the name of the host-plant in hand is not to be found among those of the host-index, it is not to be assumed that this gives any reason for supposing that the fungus is a new species, as the host list is necessarily very incomplete ; in such cases the keys to the genera and species must be consulted.

host-plants of very different affinities. I have observed *Phyllactinia corylea* on hosts belonging to 48 genera, in 27 different families, and *Erysiphe polygoni* on 190 different species of host-plants, belonging to 89 genera. The latter species has been reported on 146 additional host-plants (some of which, however, must be considered doubtful).

The members of the *Erysiphaceae* fall into the following divisions; 15 species and 2 varieties are confined to a single species of host-plant; 15 species and 5 varieties to species belonging to one genus; 4 species and 1 variety to those belonging to one family, and 15 species and 3 varieties show little or no preference in selecting their hosts. In the species of the first division it seems reasonable to suppose that the connection between host and parasite must be a very intimate one. In those of the last division it seems probable that the connection is slight.

The number of cases in which more than one species or variety of mildew has been observed on one species of host-plant is rather large; on one host-species five different mildews have been recorded in one case, four in four cases, three in 24 cases, and two in 163 cases. These numbers have been obtained by taking into account all the published records, and are therefore (especially with regard to those cases in which two species of mildew have been recorded on the same host) probably far too high. In the present confusion that exists concerning the hosts of many species it is impossible to give exact numbers; probably, in the last case mentioned, 100 in the place of 163 would be nearer the mark. In many cases it is probable that an error in identification has led to different species of the *Erysiphaceae* being recorded for one host-plant. For instance, on *Verbascum phlomoides* I have seen *Erysiphe taurica*; *E. cichoracearum* is recorded by Magnus, and *E. polygoni* by Dom. Saccardo; *E. cichoracearum* grows commonly on *Achillea Ptarmica*, and it may perhaps be doubted if the two other species—*E. taurica* and *E. polygoni*, recorded on this host, really occur. It is needless to give further examples, as these can be found in the host-index. On the one hand it is quite certain that in a large number of cases more than one species of mildew grows on one host-species; on the other hand, it is equally certain that in many of the recorded cases of this kind wrong determinations have been made. It is hoped

that by means of the asterisk prefixed to the plants in the host-index attention will be directed to this point, and so lead mycologists to clear up these doubtful records. The work is difficult, as it consists in many cases in proving that a certain species does not grow on a certain host-plant; this can only be hoped to be accomplished by continued observations for many years, at the end of which time it might be safe to disregard many published records.

One curious source of error still remains to be noticed. It has, up to the present, been generally supposed that it is a safe practice to consider perithecia found on any host-plant as originating there. Many cases that have come under consideration prove that this is not so. In some instances stray perithecia of certain species occurring on strange hosts have been published as new species. This is the case with "*Erysiphella Carestiana*," which was founded on perithecia of *Phyllactinia corylea* accidentally adhering to the pileus of *Fomes fomentarius*. "*Uncinula Coumbiana*" is, I believe, merely *U. salicis* on the leaves of *Scutellaria*, and "*Erysiphe vitigera*" appears to have been established on stray perithecia of *E. cichoracearum*, occurring on the vine. Similiar cases, mentioned in detail under the respective species are the following: *Uncinula salicis* on *Artemisia vulgaris*, *U. prunastri* on *Lonicera Xylosteum*, *U. Delavayi* on *Celtis*, *Phyllactinia corylea* on probably many herbaceous hosts and *Microsphaera alni* on *Populus grandidentata*. *Uncinula geniculata* has occurred apparently accidentally on *Hydrophyllum appendiculatum*. I have seen, in herbarium specimens, *Podosphaera tridactyla* adhering in a tangled mass to a leaf of *Fagus sylvatica*, and perithecia of *Phyllactinia corylea* accidentally present on a rose leaf. A few perithecia of *Microsphaera alni* have been seen among those of *M. diffusa* on a leaf of *Desmodium paniculatum*, and, also, in a specimen named *M. grossulariae*, adhering to the margins of gooseberry leaves.

The accidental presence of perithecia on plants may perhaps be accounted for in some cases by the rubbing together of dried specimens in herbaria, or possibly by the repeated use of the same drying paper to which perithecia would adhere, in pressing the leaves.

DISTRIBUTION.

The *Erysiphaceae* have practically a world-wide distribution. It can, however, be said that their headquarters are in the North Temperate Zone, as they occur in the greatest numbers in the United States and parts of Europe. The most southern record is that of *Phyllactinia* at the Beagle Channel, Tierra del Fuego, in the extreme south of South America. One species probably, *Erysiphe cichoracearum*, has been recorded from the tropical island of St. Thomas, off the west coast of Africa; *Phyllactinia corylea* occurs in Guatemala, and *Sphaerotheca pannosa* is reported from the West Indies. As regards the northern limit, *Erysiphe cichoracearum* is found in Lapland, and *Podosphaera oxyacanthae* in Greenland.

As examples of species with a very wide range of distribution may be mentioned *Erysiphe polygoni*, *E. cichoracearum*, *E. graminis*, *Microsphaera alni*, *Podosphaera oxyacanthae*, *Uncinula salicis*, *Sphaerotheca humuli*, and *Phyllactinia corylea*.

Arranging the species as they occur on the main areas of land we have the following table:

	No. of species.	No. of vars.	No. of endemic species.	No. of endemic vars.
Europe,	27	5	9	3
Africa,	7	1	—	—
Asia,	25	3	4	1
Australia and New Zealand,	5	—	—	—
America,	31	7	14	5

We find, therefore, that out of the 49 species and 11 varieties of the *Erysiphaceae*, no less than 27 species and 9 varieties are endemic in the above sense, that is to say, nearly four-sevenths of the species and 9 out of the 11 varieties.

These 27 "endemic" species and 9 varieties are variously further limited in distribution, and it is interesting to note that most of them are confined either to a single species of host-plant or to one genus; *e. g.*, *Erysiphe trina* is known only from California on the single species *Quercus agrifolia*, while *E. tortilis* has a wide European range on *Cornus sanguinea*.

The number of species confined to the Old World is 18, with

4 varieties ; to the New World, 14 species with 5 varieties ; leaving 17 species and 2 varieties common to both.

In dealing with the features of distribution, however, we must remember that while Europe and the United States have been well-worked for the *Erysiphaceae*, little has yet been done in investigating the family in Africa, Asia and Australia.

An interesting fact is the occurrence in Japan of two species, *Uncinula Clintonii* and *U. polychaeta*, hitherto supposed to be endemic to America. *Sphaerotheca mors-uvae*, widely spread in the United States on species of *Ribes*, appears to be identical with the European species *S. tomentosa* growing on species of *Euphorbia*. *Microsphaera euphorbiae* is not uncommon in the United States on *Euphorbia* and *Astragalus*, and appears in Asia (Turkestan) on *Colutea* and *Astragalus* (*M. coluteae*). *Uncinula necator*, long supposed to be endemic to North America, was discovered in 1892 in France, and has now been found in species of *Actinidia* in Japan. *U. Australiana*, on *Lagerstroemia ovalifolia* in New South Wales, has been sent by Prof. Miyabe, on *L. Indica*, from Japan.

Most of the species of the *Erysiphaceae* show a wide range of variation in their characters, and the description of each species given in the following pages will usually be found to be much wider than that hitherto given by authors.

Examination of a large amount of material has shown conclusively that such characters as the persistence or evanescence of the mycelium, the size of the perithecium, the number of asci, and in many cases the number of spores are far more variable than is generally supposed. On the other hand, just as we find that a classification based on differences in the shape of the appendages divides the family into natural genera, so also we find that frequently the best specific characters are those derived from the appendages. The minute differences in the shape, mode of branching, etc., of the appendages are specifically constant, and usually show far less variation than other characters. It is important to note, however, that the mature condition of the appendages is necessary to show these specific characters ; many erroneous descriptions have arisen from the examination of only immature stages.

At the end of the synonomy of each species, a list of exsic-

cati is appended. Only those are quoted which have been personally examined, and unless prefixed by an asterisk, or followed by information as to the source, all the numbers refer to the copies in the Kew Herbarium. Those distinguished by an asterisk are to be found in the Herbarium of the British Museum (Natural History). It is necessary to state exactly what copies have been examined, as—in the case of microscopic fungi especially—different copies of the same numbers in exsiccati may contain different species.

I have not attempted to deal with the described species of *Oidium* in the present work, only mentioning those which are generally admitted to be the conidial stage of known species of the *Erysiphaceae*, as, *e. g.*, *O. Tuckeri* and *Uncinula necator*, *O. monilioides* and *Erysiphe graminis*, etc. In all probability the genus *Oidium* is not autonomous, but consists entirely of conidial forms of the *Erysiphaceae*. About 50 species of *Oidium* have been published; of these six are already known to be the conidial stage of certain species, and over twenty-five of the remaining species grow on plants known to be the hosts of species of the *Erysiphaceae*. I have not included in the descriptions of the species of the *Erysiphaceae* the characters shown in the conidial (*Oidium*) stage. In many species, indeed, this stage has not, at present, been observed. In those cases where only dried material was available, the examination would not have been satisfactory, as in studying the *Oidium*-form living material is necessary in order to arrive at such characters as the number of conidia produced in the chain, the size and shape of the ripe conidium. I hope at some future time to investigate this branch of the subject.

The material examined has been for a large part found in the rich collection of *Erysiphaceae* in the Royal Herbarium, Kew. This collection includes the types of Cooke and Peck's American species, and is especially valuable in containing Berkeley's herbarium. In this occur, besides Berkeley's types, no less than 98 specimens sent by Léveillé to this author (Léveillé's herbarium, M. P. Hariot informs me, was destroyed in 1870 during the Franco-Prussian war); also a number of specimens sent by Castagne, Roberge, etc., and a few examples from Schweinitz' herbarium. For the great facilities afforded me in the use of this collection I am under obligations to the Director of the Royal Gardens, Kew.

Next in importance has been the private collection kindly sent on loan by Prof. F. S. Earle. This contains over 800 excellent specimens of the American *Erysiphaceae*, and is valuable as being the material used by Professor Burrill and Professor Earle in their well-known work on the family (61).

For other American material I am indebted to Prof. W. Trelease, who kindly sent for examination the Herbarium of the Missouri Botanic Gardens; also to Mr. J. B. Ellis, Prof. G. P. Clinton, Prof. L. H. Pammel for the *Erysiphaceae* in the Herbarium of the Iowa State Agricultural College; and to Prof. B. T. Galloway for 150 specimens, many of great interest from the Herbarium of lhe United States Department of Agriculture. These latter are now deposited in the Royal Herbarium, Kew.

Mr. David Griffiths kindly sent me a large collection (over 100 specimens) gathered in South Dakota, Wyoming and Montana; these also are now placed in the Royal Herbarium, Kew.

M. P. Hariot courteously sent me on loan the *Erysiphaceae* contained in the Paris Museum. This collection is of great interest, as it includes Montagne's herbarium, which was examined by Léveillé. In this herbarium are about 25 specimens of Wallroth's (determined by Léveillé; see 214, p. 115); 33 specimens from Léveillé's herbarium; and numerous specimens from Castagne and other authors.

To Prof. W. Tranzschel I am indebted for the loan of a representative collection of Russian *Erysiphaceae.*

Prof. Kingo Miyabe sent a large and extremely valuable collection, accompanied by notes of Japanese specimens. This contained several species not hitherto recorded, from Asia, and included two new species and one new variety. The specimens are deposited in the Royal Herbarium, Kew.

I have to thank Prof. T. M. Fries for the loan of the collection of *Erysiphaceae* in the Upsala Museum, containing those of Fries' herbarium; Prof. L. Jost for the loan of Duby's herbarium, and also specimens from Castagne, Nees von Esenbeck, etc., contained in the herbarium of the University of Strassburg; M. Casimir de Candolle for specimens from De Candolle's herbarium; Prof. E. Fischer for Ott's herbarium in the University of Berne; Prof. E. Baroni for the collection in the Florence Museum (which contains 18 specimens from Léveillé's herbarium); Prof. A. Fischer de Waldheim for the specimens in the herbarium of the St. Petersburg Botanic Gardens; Prof. C. Gobi for those in the herbarium of the University of St. Petersburg, and Prof. J. Eriksson for his collection of Swedish *Erysiphaceae.*

I wish also to thank the authorities at the British Museum (Natural History) for giving me every opportunity of studying the collection of *Erysiphaceae* in this herbarium.

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List of new Species and Varieties

Uncinula salicis, var. *Miyabei*.
Uncinula Fraxini.
Uncinula Sengokui.
Microsphaera alni, var. *ludens*.

ERYSIPHACEAE Lév.

Parasitic on living (phanerogamic) plants ; vegetative mycelium white, external to the host-plant, either (*Erysipheae*) forming haustoria in the epidermal cells, or (*Phyllactinieae*) sending special branches for a short distance through the stomata into the intercellular spaces, and from these branches sending haustoria into the surrounding cells ; hyphae thin-walled, septate, much-branched and interwoven ; conidia large, continuous (non-septate), colorless or white, cylindrical, oblong, or barrel-shaped, produced singly or in concatenate chains in basipetal succession on erect, simple, septate, colorless conidiophores ; perithecia arising directly from the mycelium, sessile, at first colorless, then yellow, becoming finally brown or black, membranaceous, indehiscent, globose or globose-depressed, sometimes becoming concave ; walls many-layered, pseudo-parenchymatous, the apical, equatorial or basal cells of the outer wall usually giving rise to definite outgrowths, the appendages, which are either more or less similar to the mycelial hyphae, or quite distinct from them, and variously shaped, simple or branched at the apex, erect or radiating, sometimes colored ; asci one or many, arising from the base of the perithecium, colorless, cylindrical, oblong, ovate or globose, frequently pedicellate, 2–8-spored ; spores continuous (non-septate), colorless, oblong or oval, with obtuse ends, straight or rarely slightly curved ; paraphyses absent.

Sub-family Erysipheae Palla.

Mycelium wholly external to the tissues of the host-plant ; sending haustoria into the epidermal cells only.

Key to the Genera

1. Ascus solitary. 2.
   Asci several. 3.
2. Appendages of the perithecium basal, sometimes obsolete, not branched in a definite manner at the apex. *Sphaerotheca*.
   Appendages of the perithecium branched at the apex, or if unbranched, arising apically. *Podosphaera*.
3. Appendages of the perithecium nearly always simple (branched in *U. aceris* (see Fig. 87)), uncinate at the apex. *Uncinula*.
   Appendages not uncinate. 4.

4. Appendages branched in a definite manner at the apex, or if unbranched (*M. astragali*) white, assurgent and fasciculate. *Microsphaera.*
Appendages simple, or irregularly branched (no definite apical branching), sometimes obsolete, usually more or less similar to the mycelium, and interwoven with it, very rarely (*E. tortilis*) brown, assurgent and fasciculate. *Erysiphe.*

PODOSPHAERA Kunze, Myk. Heft. **2**: 111. 1823

Perithecia globose, or globose-depressed; ascus solitary, subglobose; spores eight. Appendages equatorial or apical, dark brown or colorless, dichotomously branched at the apex, branches simple and straight, or swollen and knob-shaped; very rarely (*P. leucotricha*) of two kinds, one set apical, brown, rigid, unbranched or rarely 1–2 times dichotomous at the apex, the other set basal short, flexuous, simple or vaguely branched, frequently obsolete. Etym. *πούς*, *pes*, and *σφαιρα*, *sphaera*.—Distrib. Europe, Africa, Asia, North America, and probably Australia.—4 species and 1 variety.

The single ascus separates the genus from all others of the *Erysiphaceae* except *Sphaerotheca*, from which it is at once distinguished by the definite equatorial or apical appendages. *P. leucotricha* which has hitherto been placed in the genus *Sphaerotheca*, and known as *S. mali*, is anomalous among the *Erysipheae* in possessing two kinds of appendages.

Key to the Species of Podosphaera

1. Basal appendages present, apical appendages usually unbranched. 4. *leucotricha.*
Basal appendages absent. 2.

2. Appendages erecto-fasciculate, springing from near the apex of the perithecium. 3.
Appendages more or less spreading and equatorially inserted. 4.

3. Appendages 6–12½ times the diameter of the perithecium, colorless, or occasionally pale brown towards the base. 2. *Schlechtendalii.*
Appendages 1–8 times the diameter of the perithecium, dark brown for more than half their length. 1. *oxyacanthae* var. *tridactyla.*

4. Appendages colorless, or faintly tinged with brown at the base, branches of apex not swollen. 3. *biuncinata.*
Appendages dark-brown for more than half their length, ultimate branches of the apex knob-shaped. 1. *oxyacanthae.*

1. PODOSPHAERA OXYACANTHAE (DC.) de Bary. [Figs. 96, 97, 99–108, 115]

Erysiphe oxyacanthae DC., Mém. Soc. d'Agric. Départ. Seine **10**: 235. 1807; DC. Fl. Fr. **6**: 106. 1815; Duby, Bot. Gall. **2**: 868. 1830; Dur. et Mont. Fl. d'Algér. (Crypt.) 564. 1846–9; Tul. Sel. Fung. Carp. **1**: 202, *pl. 4. f. 10.* 1861.

Alphitomorpha clandestina var. *oxyacanthae* Wallr. Berl. Ges. Nat. Freund. Verh. **1** : 36. 1819; Wallr. in Ann. Wett. Ges. **4** : 242. 1819; Wallr. Fl. Crypt. Germ. **2** : 754. 1833.

Sphaeria myrtillina Schub.; Ficin. Flor. Gegend. Dresd. **2** : 356. 1823.

Podosphaera myrtillina Kze. and Schmidt, Myk. Heft. **2** : 113. *pl. 2. f. 8.* 1823; de Bary, Beitr. Morph. Phys. Pilz. **1** : § XIII. 48. 1870; Sacc. Syll. Fung. **1** : 2. 1882; Wint. in Rabenh. Krypt. Fl. Deutschl. **1**^{2} : 29. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**^{6} : 95. 1885; Schroet. in Cohn's Krypt. Fl. Schles. **3**^{2} : 233. 1893; Jacz. Bull. l'Herb. Boiss. **4** : 744. 1896; Oudem. Rév. Champ. Pays-Bas, **2** : 81. 1897.

Erysibe clandestina Lk. in Willd. Sp. Pl. **6** : 103. 1824; Rabenh. Deutschl. Krypt. Fl. **1** : 237. 1844.

Erysiphe clandestina (*oxyacanthae*) Fr. Syst. Myc. **3** : 238. 1829.

E. myrtillina Fr. Syst. Myc. **3** : 247. 1829.

Erysibe myrtillina Rabenh. Deutschl. Krypt. Fl. **1** : 237. 1844.

Podosphaera Kunzei Lév. Ann. Sci. Nat. III. **15** : 135. *pl. 6. f. 6* (*partim*). 1851; Karst. Myc. Fenn. **2** : 198. 1873.

P. clandestina Lév. Ann. Sci. Nat. III. **15** : 36. *pl. 6. f. 5.* 1851; Cooke, Handb. Brit. Fung. **2** : 648. 1871.

P. oxyacanthae (DC.) de Bary, Beitr. Morph. Phys. Pilz. **1** : § XIII. 48. 1870; Sacc. Syll. Fung. **1** : 2. 1882; Wint. in Rabenh. Krypt. Fl. Deutschl. **1**^{2} : 29. 1884; Earle, Bot. Gaz. **12** : 26. 1884 (excl. syn. *P. tridactyla* and *Alphit. tridactyla*; Burr. and Earle, Bull. Ill. State Lab. Nat. Hist. 412. *f.* 7 (*syn. excl. partim*). 1887; Atkins. Journ. Elisha Mitch. Sci. Soc. **7** : 69. 1891; Burr.; Ell. and Everh. N. Amer. Pyren. 21. *pl. 4* (*syn. excl. partim*). 1892; Schroet.; Cohn's Krypt. Fl. Schles. **3** : 234 1893; Jacz. Bull. l'Herb. Boiss. **4** : 743. 1896; Oudem. Rév. Champ. Pays-Bas. **2** : 79. 1897.

P. minor E. C. Howe, Bull. Torr. Club, **5** : 3. 1874; Sacc. Syll. Fung. **9** : 364. 1891.

Microsphaera fulvofulcra Cooke, Grevillea, **5** : 110. 1877; Sacc. Syll. Fung. **1** : 14. 1882, and **9** : 364. 1891.

[?] *Podosphaera clandestina* Lév. var. *ramulicola* Thüm. Bull. Soc. Imp. Nat. Mosc., **56** : 126. 1882.

P. aucupariae Erikss. Fung. par. scand. exsicc. no. 233 (cum diag.) 1886; Sacc. Syll. Fung. **9**: 364. 1891.

P. myrtillina var. *major* Juel. Öfvers. K. Oet. Akad. Förh. **51**: 496. 1895.

Exsicc.: Bri. and Cav. Fung. par. 215; Rab.-Wint. Fung. Eur. 3042, 3241, 3242, 3656; Syd. Myc. March. 1064, 1543, 2227, *3559; Rehm. Ascom. 798, 900; Roumeg. Fung. Gall. Exsicc. 2735, 3736; Westend. Herb. Crypt. Belg. 280, 1057; and 740 sub *Erysiphe penicellata* var. *mespili;* Fckl. Fung. Rhen. 728, 729; Desmaz. Pl. Cr. Fr. ed. 1: ser. 1: 919; and 1305 sub *Erysibe penicellata* var. *mespili*, *ser. 2: 919, *ed. 2: ser. 1; 219; and 705 sub *E. penicellata* var. *mespili;* Ell. and Everh. N. Am. Fung. 55, 55b, 2335; *Ell. and Everh. Fung. Columb. 107; *Sacc. Myc. Ven. 1374; *Seym. and Earle, Econ. Fung. 126, 130, 132, 133, 418, 430; Lib. Pl. Cr. Ard. Fasc. **3**: 278; Karst. Fung. Enun. Exsicc. 277; de Thüm. Fung. Austr. 440, 446; Rab. Fung. Eur. 566; *Wartm. and Schenk, Schweiz. Krypt. 628; *Gandog. Fl. Alger. Exsicc. 1984; *Erikss. Fung. par scand. 32, 135; *Krieg. Fung. Saxon. 72.

Amphigenous, mycelium variable, sometimes persistent in thin patches, at others wholly evanescent; perithecia scattered to more or less densely gregarious in clinging masses, subglobose, 64–90 μ in diameter, cells 10–18 μ wide; appendages spreading, more or less equatorially placed, occasionally springing from nearer the apex, extremely variable in number and length, from 4–30 in number, and from ½–6, or rarely 10 times the diameter of the perithecium, usually unequal in length on the same perithecium, septate, dark brown for more than half their length, usually nearly to the apex, becoming thick-walled throughout, with the lumen more or less obliterated, apex 2–4 times dichotomously branched, branches usually short and equal (sometimes slightly elongated), ultimate branches rounded, swollen, and more or less knob-shaped; ascus broadly obovate, broadly oblong, or subglobose, variable in size, 58–90 × 45–75 μ; spores normally 8, very rarely 6, variable in size, 18–30 × 10–17 μ.

Hosts.—Amelanchier Canadensis, Crataegus Azarolus (272), *C. coccinea, C. Crus-galli, C. Oxyacantha, C. rivularis, C. sanguinea* (350), *C. spathulata, C. subvillosa* (269), *C. tomentosa* and vars. *punctata* and *pyrifolia, Diospyros Virginiana* (299), *Prunus Americana, P. avium, P. Besseyi, P. Cerasus, P. Chicasa* (324), *P. de-*

missa, P. domestica, P. Pennsylvanica (382), *P. Persica* (382), *P. pumila, P. serotina, P. Virginiana, Pyrus Aucuparia, P. coronaria* (97) (137), *P. Cydonia, P. Germanica, P. Malus, Spiraea betulifolia, S. discolor* (159), *S. salicifolia, S. tomentosa, Vaccinium intermedium* (319), *V. Myrtillus, V. uliginosum.*

Distribution.—Europe: Britain, France, Belgium, Netherlands (253), Germany, Switzerland, Italy, Austria-Hungary, Denmark, Norway, Sweden, Finland, Russia. Africa: Algeria. Asia: Siberia (Minussinsk) (350), Japan. North America: United States—Maine (163), Vermont, Massachusetts, Connecticut, New York, New Jersey (53), Virginia, North Carolina, Ohio (71) (324), Michigan, Indiana, Alabama, Illinois, Wisconsin, Missouri, Iowa, South Dakota, Nebraska, Kansas, Montana, Idaho, Utah (363), Wyoming, Colorado, California. Canada—Ontario, New Brunswick, Greenland (300).

Examination of a very large series of specimens has convinced me that the plants hitherto known as *Podosphaera oxyacanthae* and *P. myrtillina* are not specifically distinct. The distinguishing characters relied upon have been these: *P. oxyacanthae*, appendages 8 or more, shorter than or about equaling the diameter of the perithecium; *P. myrtillina*, appendages 4–10, spreading on all sides, or even deflexed, 3 or more times exceeding the diameter of the perithecium. In Europe these two forms, *P. oxyacanthae* on *Crataegus* and *Mespilus*, and *P. myrtillina* on *Vaccinium Myrtillus* and *V. uliginosum*, could perhaps, taken by themselves, be kept distinct as varieties, for the distinctive characters are scarcely of specific value, besides occasionally showing a tendency to fail. On dealing with other material, however, it is seen very clearly that there exists every intermediate link between these two forms.

Let us take first the European form on *Pyrus Aucuparia*, described by Eriksson as a new species. *P. aucupariae*, with the following diagnosis: "Hypophylla. Mycelium evanidum. Perithecia sparsa, sphaeroidea, minuta. Appendices paucae (4–6), diametrum perithecii ter superantes, e parte superiore perithecii radiatim divergentes * * * Mea species *P. aucupariae* differt a *P. oxyacanthae* appendicibus longioribus, a *P. myrtillina* Kze. appendicibus paucis, a *P. tridactyla* (Wallr.) de Bary appendicibus radiatis, ab his utrisque peritheciis hypophyllis."

In Eriksson's own specimens (Fung. par. scand. exsicc. nr. 233), however, the appendages measure 1½ to 2¾ (averaging 2) times the diameter of the perithecium. In the specimen in Rab.-Wint. Fung. Eur. 3241 the appendages are slightly more unequal in length, varying from 1–3 times the diameter of the perithecium. As regards the number of the appendages, this is in Eriksson's *P. aucupariae* 4–8, and in European specimens of *P. myrtillina*, 4–10.

On the whole, *P. aucupariae* connects *P. oxyacanthae* with *P. myrtillina*, and cannot possibly be considered a separate species.

It is, however, in dealing with American specimens that we see how completely "*P. myrtillina*" merges into *P. oxyacanthae*.

The American plant is often erroneously called "*P. tridactyla*" by American mycologists, or *P. Kunzei* (which includes *P. tridactyla*) is quoted wholly as a synonym; other authors, *e. g.*, Earle (110), have supposed that the European *P. myrtillina* might be something different from any of the American forms. As a matter of fact, were the species *P. oxyacanthae* and *P. myrtillina* to be kept distinct most the American forms would fall under the latter, although occurring on other hosts than *Vaccinium*, while *P. oxyacanthae* would have to be confined to certain forms on *Crataegus*, and to the form on *Spiraea*, which has been called *P. minor* E. C. Howe.

A study of American examples on *Crataegus*, *Prunus*, *Pyrus*, *Spiraea*, etc., shows conclusively, however, that only a single species exists, but one which is extremely variable in the length and number of its appendages. Earle has some interesting remarks in his "Notes on the North American Forms of *Podosphaera*" (110) on the subject of this variability, and this author's conclusion that all the American forms must be included under the single species *P. oxyacanthae* is undoubtedly correct. A specimen in Professor Earle's herbarium shows clearly how completely the long- and short-appendaged forms are connected. This specimen is labeled "on *Crataegus*, Deland, Illinois, Sept., 1889. A. B. Seymour." Many of the perithecia are identical in the few short appendages with those of the European *P. oxyacanthae* on *Crataegus Oxyacantha*; other perithecia show, quite gradually, an in-

crease in both the number and length of the appendages, until they cannot be separated from the more common long-appendaged American form. *P. minor* Howe (*Microsphaera fulvofulcra* Cooke) on *Spiraea tomentosa* also shows much the same variation in the length of the appendages.

These short-appendaged forms show the range of variation of *P. oxyacanthae* in one direction, in the other we meet with a very long "appendaged form on *Vaccinium uliginosum*, which has been described as '*P. myrtillina* var. *major* Juel.'" Professor Juel has kindly sent me a specimen (now in the Kew Herbarium) of this form. In this specimen I find that contiguous perithecia have appendages varying from 2½ to 10 times the diameter of the perithecium. I have seen exactly the same form—with the appendages varying in length from 6–10 times the diameter of the perithecium—in Russian specimens in Professor Tranzschel's herbarium. As this great variation occurs in perithecia on the same leaf, it is obviously impossible to treat the length of the appendages as a character of diagnostic value, and in other respects the form shows no differences.

In conclusion, it appears then that we must allow to the present species—*P. oxyacanthae*—a range of variation in the length of its appendages of from less than the diameter of the perithecium to ten times exceeding it. The existence of a perfect series of connecting links justifies this treatment, as does also the fact that similar variation in the same characters is found in other species. In the var. *tridactyla* of the present species the appendages vary from 1–8 times the diameter of the perithecium. In the series of forms of *Microsphaera alni*, the one long known as "*M. Hedwigii*" corresponds exactly in the short, few appendages with the form of *P. oxyacanthae* on *Crataegus Oxyacantha* and *Mespilus*, and mycologists now admit that "*M. Hedwigii*" must be united with the longer appendaged forms of *M. alni*.

In some examples of American *P. oxyacanthae* on *Crataegus* the perithecia form densely matted patches about the midrib of the leaf. Perhaps the plant described by Thümen (350) as *Podosphaera clandestina* var. *ramulicola* is a similar form. The following description is given: "Periitheciis dense aggregatis, numerosissimis, pulviniformibus; mycelio candido, non evanido; ascis sporisque

typicis. In ramulis vivis *Crataegi sanguineae* Pall. in sylvis pr. Minussinsk.

P. oxyacanthae is known in America as the "Cherry Powdery Mildew"; also as the "Apple Powdery Mildew," although it is possible that under the latter name *P. leucotricha* is sometimes intended.

Pammel (266 and 267) describing the "Cherry Powdery Mildew" states that the disease can be treated successfully with Bordeaux mixture and ammoniacal carbonate of copper.

Galloway (136) speaking of an "Apple Powdery Mildew," which was identified as the present species, states that it causes the most serious injury to fruit trees, especially to the young stock of nurseries. In one case, owing to the presence of the mildew, of some stocks budded, only about two thirds of the buds took. Full details are here given of the preparation and application of the ammoniacal carbonate of copper, which was found perfectly successful as a fungicide. The interesting statement is made that "*P. oxyacanthae* probably winters in a mycelial stage."

Benson (24) attributes a disease on apple trees, widely spread over the colony of New South Wales, to "*P. Kunzei* Lév.," and recommends the diseased trees, when in bud, to be sprayed with Bordeaux mixture, followed with a dressing of ammonio-carbonate of copper. As the fungus was, apparently, observed only in the conidial stage, the identification with the present species remains doubtful.

Waite (382) states of the present species that "young cherry trees are the chief sufferers from its attacks, but it also does considerable harm to the peach and to young apple trees in the nursery, and occasionally seriously injures the quince." It is also noted that the most destructive form of the fungus usually bears but a few perithecia, and often fails to produce any before frost puts an end to the season's growth. Spraying with a mixture of half an ounce of potassium sulphide in a gallon of water is recommended.

P. oxyacanthae sometimes attacks *Crataegus Oxyacantha* so severely that it kills the plant. Eriksson (119) records such cases from the neighborhood of Stockholm, where young trees up to 4 feet high were destroyed. It is also stated that the fungus frequently produces no perithecia on this host.

Rose (299) records the occurrence of *P. oxyacanthae* on the Persimmon (*Diospyros Virginiana*), and remarks that all the asci examined "contained 9 spores, differing in this respect from any of the species of *Podosphaera*.

Var. TRIDACTYLA (Wallr.) [Figs. 109–114]

Alphitomorpha tridactyla Wallr. Fl. Crypt. Germ. **2**: 753. 1833.

A. (*Erysiphe*) *Brayana* Doith, Flora, **21**: 475. *pl. 1. f. 7.* 1838.

Erysibe tridactyla Rabenh. Deutschl. Krypt. Fl. **1**: 237. 1844.

E. Brayana Rabenh. Deutschl. Krypt. Fl. **1**: 237. 1844.

Erysibe tridactyla Desmaz. Ann. Sci. Nat. III. **3**: 361. 1845.

Podosphaera Kunzei Lév. Ann. Sci. Nat. III. **15**: 135 (partim). 1851; Cooke, Handb. Brit. Fung. **2**: 647 (excl. fig.). 1871.

Erysiphe tridactyla Tul. Sel. Fung. Carp. **1**: 201. *pl. 4. f. 11–13.* 1861.

Podosphaera tridactyla (Wallr.) de Bary, Beitr. Morph. Phys. Pilz. **1**: § XIII. 48. 1870; Sacc. Syll. Fung. **1**: 2. 1882; Win. in Rabenh. Krypt. Fl. Deutschl. $\mathbf{1}^2$: 28. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 95. 1885; Schroet. in Cohn's Krypt. Fl. Schles. **3**: 233. 1893; Jacz. Bull. l'Herb. Boiss. **4**: 744. 1896; Ouden. Rév. Champ. Pays-Bas. **2**: 81. 1897.

Exsicc.: Sacc. Myc. Ven. 783; and 616 sub *Uncinula Wallrothii;* de Thüm. Fung. Austr. 122, 439 and 463 sub *U. Wallrothii;* Rehm. Ascom. 850; Rab. Fung. Eur. 565, 565b, 2412; Rab. Herb. myc. ed. 2, 475; and 487 sub *Erysibe adunca* var. *Padi;* Vize. Fung. Brit. 195; Fckl. Fung. Rhen. 726, 727; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 1514,* 2194 and *ed. 2, ser. 1, 1014, 844; Syd. Myc. March. 1141; Roumeg. Fung. Gall. exsicc. 1498; de Thüm. Myc. univ. 159; * Erbar. Critt. Ital. ser. 2, 494; Brit. & Cav. Fung. par. 292; * Erikss. Fung. par. scand. 136.

Amphigenous; mycelium usually evanescent, rarely subpersistent; perithecia scattered to more or less densely gregarious, subglobose, 70–105 μ in diameter, cells 10–15 μ wide; appendages 2–8, usually about 4, 1–8 times the diameter of the perithecium, usually unequal in length on the same perithecium, springing in a cluster from the apex of the perithecium, more or less erect, when long often fasciculate, septate, dark brown for more than half their

length, apex 3–5 (rarely 6) times dichotomously branched, primary branches (and rarely the secondary) usually more or less elongated, and sometimes slightly recurved, ultimate branches rounded, swollen and more or less knob-shaped; ascus globose or subglobose, 60–78 × 60–70; spores 8, 20–30 × 13–15 μ, sometimes slightly curved.

Hosts.—*Prunus Armeniaca, P. communis, P. domestica, P. insititia, P. Padus, P. spinosa, Spiraea Douglasii* [*Pyrus Aucaparia* (319)].

Distribution.—Europe: Britain, France, Belgium (46, 209). Netherlands (263), Germany, Switzerland (176), Italy, Austria-Hungary, Denmark, Norway, Sweden, Russia. Asia: Japan. North America: United States, Washington.

The apical insertion of the more or less erect, often fasciculate appendages, together with a marked tendency for the apex of the appendages to become more elaborately divided are the characteristic features of the present plant. The apex of the appendages, besides being more branched than in the type, frequently develops long primary branches; this latter character is not, however, absolutely confined to the present variety, as it occurs rarely in examples of *P. oxyacanthae.* Considering European specimens alone, it might be contended that these characters are constant and important enough to give a specific rank. Occasionally, however, amongst these, examples occur in which a slight spreading tendency is shown in the appendages. This tendency is more marked in the American example, which consequently forms a link with *P. oxyacanthae.*

Without exception all the American plants labelled "*P. Kunzei*" (the name under which Léveillé united "*P. tridactyla*" and "*P. myrtillina*") that I have seen, belong to *P. oxyacanthae*, and the only specimen which belongs to the present variety is one sent to me from the herbarium of the U. S. Dept. of Agric. named "*Sphaerotheca humuli* (DC.) Burr. on *Spiraea Douglasii*, Seattle, Washington, Oct., 1891 (A. M. Parker)." In this specimen (now in the Kew Herbarium) the long, more or less erect appendages springing from near the apex of the perithecium refer the plant to the var. *tridactyla*, and are quite different to the appendages of the form of *P. oxyacanthae* which occurs commonly on American species of *Spiraea.* Nevertheless, in some perithecia

the appendages here and there have a tendency to spread, and thus show characters connecting *P. oxyacanthae* with its var. *tridactyla.*

The published records of "*P. tridactyla*" (Wallr.) from America (53) (249) (366), etc., almost certainly all belong to *P. oxyacanthae*, as the former name has been in error, commonly used by American mycologists as a synonym of the latter species.

The Japanese plant occurs on *Prunus communis*, and was sent to me by Professor Miyabe. The appendages are few, short, and fasciculately erect, with a large very widely branched apex.

Schroeter's (319) record of the occurrence of the present plant on *Pyrus Aucuparia* probably refers to *P. oxyacanthae.*

McAlpine (225) records "*P. tridactyla* de Bary" on "young leaves and shoots of Apple," from Victoria and New South Wales, but very probably this record rests merely on the occurrence of an *Oidium* on this host, and the fungus may prove to belong to *P. leucotricha;* the Apple is not known as a host-plant for the var. *tridactyla.*

In the present variety the length of the appendages varies from 1–8 times the diameter of the perithecium, and there is also great variation in the manner of the branching of the apex (see Figs. 109–113).

2. P. SCHLECHTENDALII Lév. [Figs. 118, 123]

P. Schlechtendalii Lév. Ann. Sci. Nat. III. **15**: 29. *pl. 6. f. 7.* 1851; Sacc. Syll. Fung. **1**: 3. 1882.

Hypophyllous; mycelium evanescent; perithecia scattered, subglobose, 78–90 μ in diameter, cells 10–15 μ wide; appendages 5–12, unequal in length, 6–12½ times the diameter of the perithecium, erecto-fasciculate, springing from the apex of the perithecium, and forming a long flaccid, somewhat flexuous bundle, which is more or less entangled in the hairs of the leaf, septate, colorless above, occasionally pale brown towards the base, apex 2, very rarely 3 times dichotomously branched, end of ultimate branches more or less thickened, primary and secondary branches usually recurved; ascus subglobose, 76–84 $\times$ 68–74 μ; spores 8, 23–28 $\times$ 13–15 μ, sometimes slightly curved.

Hosts.—Salix alba (214), *S. viminalis.*

Distribution.—Europe: France.

There is a good specimen of this extremely interesting species

in Berkeley's Herbarium at Kew, sent to that author by Léveillé himself. *P. Schlechtendalii* has apparently disappeared since its discovery in 1851; I have seen no other example than the one mentioned above, and it is very probable that the Kew specimen is the only one in existence.

Quite lately (1897) Speschnew (338) has recorded *P. Schlechtendalii* as occurring, rarely, on the willows of the islands of R. Alazan, Transcaucasia. If the identification is correct, the reappearance of this long-lost species in so distant a locality is very interesting.

Léveillé (214, p. 137), found the original species at Neuilly, near Paris, on the leaves of *Salix alba* and *S. viminalis*, and in his description makes the following observations: "Cette espèce, qui n'a pas encore été signalée, est une des plus remarquables et des plus faciles à reconnaître. Ses appendicules, au nombre de huit ou dix, ont de dix à onze fois la longueur du diamètre des conceptacles, et leur extrémité présente des rameaux filiforme contournés en vrille. Cette extrémité est assez difficile à voir; il faut beaucoup de précautions pour la détacher, sans la briser, des poils qui recouvrent la face inférieure des feuilles."

3. P. BIUNCINATA Cooke & Peck [Fig. 98]

P. biuncinata Cooke & Peck, Journ. of Bot. **1**: 11. 1872; Peck, Reg. Rep. **25**: 94. 1873; Sacc. Syll. Fung. **1**: 3. 1882; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 69. 1891; Burr. in Ell. and Everh. N. Am. Pyren. 22. 1892.

EXSICC.: de Thüm. Myc. Univ. 2050; Ellis, N. Amer. Fung. 1326; Rab.-Wint. Fung. Eur. 3540; *Seym. and Earle, Econ. Fung. 135; *Ell. and Everh. Fung. Columb. 509.

Amphigenous; mycelium persistent, arachnoid and effused, or evanescent; perithecia scattered, or often densely gregarious, subglobose, 55–72 μ in diameter; appendages 4–15, equatorially placed and spreading, 3–5 times as long as the diameter of the perithecium, straight or slightly flexuous, aseptate, smooth, usually colorless throughout, sometimes with a faint tinge of brown at the base, narrow (4–5 μ wide), thin-walled above, becoming thick-walled and refractive at base, apex once or rarely twice dichotomously branched, primary branches long or short, more or less recurved; secondary branches, when present, shorter,

tips of ultimate branches straight, blunt; ascus globose, or subglobose, with a minute stalk, 45–50 × 40–48 μ; spores 8, 20–24 × 11–13 μ.

"This is a very distinct species. The branches at the tips of the appendages are slightly curved, and diverge nearly at right angles to the appendage. When mature, the plants often become collected in entangled masses, giving the leaf the appearance of being coated with dusty cobwebs" (Peck, Reg. Rep. **25**: 95).

Host.—*Hamamelis Virginiana.*

Distribution.—North America: United States—Massachusetts, Connecticut, New York, North Carolina, Ohio (71), Indiana, Alabama (12), Illinois, Wisconsin. Canada—Ontario.

P. biuncinata is known at once by the long spreading colorless appendages. The apex of the appendages is usually only once forked, rarely the primary branches are again divided (see fig. 98). I have once observed two asci in the same perithecium.

4. P. LEUCOTRICHA (Ell. and Everh.) [Figs. 119–122]

Sphaerotheca leucotricha Ell. and Everh. Journ. Mycol. **4**: 58. 1888; Sacc. Syll. Fung. **9**: 365. 1891.

S. mali Burr. in Ell. and Everh. N. Amer. Pyren. 6 (excl. syn. *Erysiphe mali* Duby). 1892; Magnus, Bericht. Deutsch. Bot. Gesell. **16**: 333. *pl. 21.* 1898; Grout, Bull. Torr. Club, **26**: 374. *pl. 364.* 1899.

Albigo leucotricha (Ell. and Everh.) Kuntze, Revis. Gen. Plant. 3^2: 442. 1892.

EXSICC.: *Syd. Myc. March. 3161, sub *S. castagnei* Lév.; Warlich, Parasit. Pilz. 17, 18, sub *S. castagnei* Lév. (in Herb. Hort. Imp. Petropol.).

Mycelium amphigenous, persistent, thin, effused; perithecia densely gregarious, rarely more or less scattered, 75–96 μ in diameter, subglobose or sometimes slightly pyriform, cells 10–16 μ wide, usually 10 μ; appendages of two kinds, one set springing from the apex of the perithecium, the other inserted basally; apical appendages 3–11 in number, usually 3–5, more or less widely spreading, or erecto-fasciculate, 4–7 times the diameter of the perithecium, septate when young, becoming thick-walled with the lumen more or less obliterated, colored dark brown in the lower half, paler towards the tip, apex undivided and blunt, or rarely once or twice dichotomously divided; basal appendages

sometimes nearly obsolete, sometimes well-developed, short, more or less tortuous, pale brown, simple or irregularly branched; ascus oblong to subglobose, 55–70 × 44–50 μ; spores 22–26 × 12–14 μ, crowded in the ascus.

Hosts.—Pyrus Malus, P. Sieboldi.

Distribution.—Europe: Germany, Austria-Hungary (Tyrol), Russia (Tauria). Asia: Japan. North America: United States: Vermont, Wisconsin, Mississippi (60), Iowa, Missouri (117), Kansas (154).

In its characteristic form this species, when in fruit, produces matted patches on the young stems of the apple, occasionally occurring on the petioles or very rarely scattered on the leaves. The patches of densely compacted perithecia among the persistent mycelium, from their long, more or less erect rigid appendages, give a densely hirsute appearance to the infected stem. These apical appendages are, however, apparently very deciduous.

The present species was first described in 1888 as *Sphaerotheca leucotricha* by Ellis and Everhart (117). Burrill (60), in 1892 changed the name to *S. mali* (Duby), identifying it with the *Erysiphe mali* of that author. Burrill remarked as follows: "This exceedingly interesting species has not been well separated from *Podosphaera oxyacanthae* which occurs on the same host, and to casual observation has much the same appearance. In our species the tips of the large appendages are occasionally forked (once or even slightly twice), which again may have been confusing. But these vague stiff branches are totally unlike the dichotomous divisions of *Podosphaera*, and otherwise the species are very distinct. The tuft of short, interwoven, rudimentary appendages, like a dense cluster of short roots, is a very characteristic mark." Duby's *Erysiphe mali* Bot. Gall. **2**: 869, however, is not the present species but is *Phyllactinia corylea*, as an examination of the type in Duby's herbarium at the University of Strasburg showed.

From the study of many examples of the present plant, including authentic specimens kindly sent by Professor Ellis, I am led to refer the fungus to the genus *Podosphaera* rather than to *Sphaerotheca*. The apical appendages are quite different from anything found in the genus *Sphaerotheca*, while similar in structure and insertion to those of *Podosphaera oxyacanthae* var. *tri-*

dactyla, to which plant I consider *P. leucotricha* to be most nearly allied. From all known species of *Erysipheae* the present plant differs in possessing two kinds of appendages, and suggests, I think, the manner in which *Sphaerotheca* may have arisen from some such genus as *Podosphaera*. In the present species there are signs that the more specialized apical appendages are beginning to die out, as is shown by the fact that these only rarely develop to the stage of forking, commonly remaining undivided and blunt at the apex. On the other hand, the *Sphaerotheca*-like basal appendages have already appeared. These are sometimes obsolete, sometimes well developed and densely clustered.

P. leucotricha was known only from North America, until Magnus (228) recently reported it from the Tyrol. It appears certain, however, that it is really quite common in parts of Europe in the *Oidium* stage on the young stems and buds of apple, but that it has been passed over on account of the fact that it only very rarely produces perithecia. Professor Magnus kindly sent me his specimens from the Tyrol for examination, and I found them to agree perfectly with American examples.

Quite similar to the Tyrolese specimens are Russian ones which I have found contained in the Herbarium of St. Petersburg, under the name of *Sphaerotheca castagnei* (W. Wahrlich, Parasit, Pilze, 17 and 18); this is also the case with the specimens (similarly named) from Germany issued in Syd. Myc. March. no. 3161.

P. leucotricha has also occurred among the Japanese *Erysiphaceae* sent to me by Prof. Miyabe. This example (now in the Kew Herbarium) is growing on *Pyrus Toringo* (*P. Sieboldi*), and is without doubt the same as the American and European species. The apical appendages are here sometimes very poorly developed, or even apparently absent, sometimes long and characteristic; the curious root-like basal appendages are developed prominently. The perithecia are clustered in the characteristic manner, forming blackish masses on the persistent white powdery mycelium. This occurrence, besides adding Asia to the range of distribution, gives a new host-plant for the species.

P. leucotricha is so prevalent in some parts as to form a disease. Pammel (267) says "In some parts of the United States apple seedlings are seriously affected with this disease. It rarely affects

old trees but is especially common on "suckers," coming up around large trees in the orchard and nursery." Ammoniacal carbonate of copper and Bordeaux mixture were found efficacious as fungicides. It is probable that the common American "apple powdery mildew" disease, generally attributed to *P. oxyacanthae*, is in many cases caused by the present species.

Sorauer has given an account in Hedwigia (332) of a mildew disease of apple trees, in which the fungus is identified as "*Sphaerotheca Castagnei* Lév. f. *mali*." Professor Sorauer kindly sent me a series of microscopical slides of this mildew, and in these the characteristic perithecia of the present species are clearly to be seen. The thick-walled septate rigid appendages are wrongly described in Hedwigia as being basal. They are in reality (as the specimens show) apical; most of the perithecia possess also the characteristic root-like basal appendages. Professor Sorauer (*loc. cit.*) gives some interesting details of the manner in which the fungus attacks the apple trees, and mentions that, in severe cases, the weaker shoots of the tree are killed. It is also stated that a hibernation of the mycelium takes place on the young shoots.

Cobb (73, p. 279) gives an account of a disease prevalent in Australia, called the "powdery mildew of the apple." No perithecia were found by the author, although the fungus is referred to "*P. Kunzei* Lév." It is, however, more probable from the description that *P. leucotricha* is the cause of the disease. Some interesting information is given, as follows: "No account of the diseases of the apple would be complete without mention of the powdery mildew which does so much damage to young apple-trees (especially seedlings) in nurseries. In Australia the disease is by no means confined to nurseries. I have repeatedly had examples sent in from trees two, three, and four years old; in fact, orchardists send in this disease oftener than any other apple disease, scab excepted; so there can be no doubt that it is a plague to them as well as to nurserymen. * * * The leaves near the ends of the branches are the first to go." Spraying with ammonio-carbonate of copper or Eau Céleste is recommended.

Although *P. leucotricha* is at present supposed to be a rare species, it will very probably prove to be widely distributed and common, and has most likely been hitherto passed over by my-

cologists on account of the peculiarity it possesses of very rarely forming perithecial fruit; in its conidial stage it is probably frequently recorded as *P. oxyacanthae.* It will probably be found to occur in Britain, although I have not at present seen an example. It is very probable that what has been known as *Oidium farinosum* Cooke will prove to be the conidial stage of the present species. This *Oidium* is not uncommon on apples in some parts of England, and attacks especially the young leaves and leaf-buds, causing the leaves to fall prematurely and hindering or completely stopping the formation of young wood.

A good account and figure of *P. leucotricha* has been recently given by Grout (154) in the Bull. Torr. Club.

SPHAEROTHECA Lév. Ann. Sci. Nat. III. **15**: 138. 1851*

Perithecia subglobose, ascus solitary, 8-spored. Appendages floccose, brown or colorless, spreading horizontally and often in-

* Kuntze (207) has recently stated that the name *Sphaerotheca* for the present genus must give way to the earlier name *Albigo.* Kuntze remarks: *Albigo* Steud. "Ehrh." Nomencl. (1824) Crypt. 52 and 54 = *Sphaerotheca* Lév. 1851. Es ist *Albigo humuli* Steud. "Ehrh." = *Albigo macularis* Streinz. Nom. 270. "Ehrh. in sched." = *Alphitomorpha macularis humuli* Wallr. * * * *Albigo* ist zwar ein nomen seminudum, scheint mir aber sicher recognoscirbar." Kuntze then proceeds to transfer to *Albigo* all the species of *Sphaerotheca* mentioned in Saccardo's Sylloge. Magnus (232) has criticised the above statements and expressed the opinion that the name *Albigo* has no claim to be adopted, but has suggested that perhaps the name *Sphaerotheca macularis* (Ehrh.) ought to be employed in the place of *S. humuli* DC.

Neither Kuntze nor Magnus, however, reached the origin of the name *Albigo.* This is found in Ehrhart's Beitr. zur Naturkunde, 7: 84. 1792, where the following description is given: "Mehlthau (*Albigo* mihi zum Unterschied von der Rubigine (Rost, Rötheln, Karfaugel) * * * ist ein weisslichtes, staubartiges Wesen, welches gewöhnlich auf der untern Seite der Blätter des Hopfens, der Erbsen, und mehreres Pflanzen, sitzet, und zur Zeit der Réife hin und wieder mit kleinen, schwarzen Kügelchen bestreuet ist." Ehrhart concludes by saying that this substance is really a fungus—"und zwar der *Mucor Erysiphe* Linn. ist. Wer ihn aus dieser Beschreibung nicht kennen lernen kann, der schlage meine Plantas cryptogamas, n. 100, nach, wo er getrocknete Exemplare davon finden wird." M. P. Sydow kindly consulted for me the copy of Ehrhart's Exsiccati in the Berlin Museum, and informs me that the specimen No. 100 is labelled merely *Mucor Erysiphe* Linn. No mention of *Albigo* occurs, nor is any diagnosis given. As Ehrhart's remarks quoted above show, this author used the word *Albigo* in a quite general sense for all mildews, and we find it nowhere defined as a genus. Consequently, there are no grounds for substituting this name for Léveille's *Sphaerotheca.* The name "*S. macularis* (Ehrh.)" which Magnus has supposed should possibly supercede that of *humuli* DC. for the Hop Mildew, has also no claim to be recognized.

terwoven with the mycelium, simple or vaguely branched; frequently obsolete. Etym. σφαῖρα, *sphaera*, and θήκη, *theca*.

Distribution.—Europe, Africa, Asia, Australia, North and South America—5 species and 1 variety.

The single ascus and floccose appendages, more or less resembling the mycelial hyphae, separate *Sphaerotheca* from all other genera. The most interesting features shown are the production of special thick-walled, interlaced hyphae from the vegetative mycelium, forming a persistent pannose covering for the more or less immersed perithecia (*S. pannosa*, *S. lanestris*, etc.) and the complete separation of the inner wall of the perithecium from the outer, which takes place is some species (*S. phytoptophila*, *S. lanestris*). *S. phytoptophila* only occurs, apparently, in association with a species of gall-mite (*Phytoptus*).

Key to the Species of Sphaerotheca

1. Mycelium persistent, thick, pannose, forming dense patches composed of special hyphae, in which the perithecia are more or less immersed. 2.
   Mycelium without these characters. 4.

2. Persistent mycelium usually satiny and shining, white, sometimes becoming gray or pale brown. 2. *pannosa*.
   Persistent mycelium dark brown. 3.

3. Inner wall of perithecium separating from the outer, hyphae of persistent mycelium very tortuous. 4. *lanestris*.
   Inner wall not separating, hyphae straighter. 3. *mors-uvae*.

4. Perithecia 60–78 μ in diameter, ascus 60–75 $\times$ 42–50 μ, inner wall of perithecium separating from the outer. 5. *phytoptophila*.
   Perithecia 50–120 μ in diameter, ascus 45–90 $\times$ 50–72 μ; inner wall scarcely separating. 5.

5. Cells of outer wall of perithecium 10–20 μ wide, averaging 15 μ. 1. *humuli*.
   Cells 20–30 (rarely 40) μ wide, averaging 25 μ. 1. *humuli*, var. *fuliginea*.

1. SPHAEROTHECA HUMULI (DC.) Burr. [Figs. 116, 117]

Mucor Erysiphe Linn. Sp. Pl. **2**: 1186 (partim). 1753.

Sclerotium Erysiphe Pers. Obs. Myc. **1**: 13 (partim). 1796; Pers. Syn. Fung. 124 (partim). 1801.

Erysiphe humuli DC. Fl. Fr. 6: 106. 1815; Duby, Bot. Gall. **2**: 868. 1830; Tul. Sel. Fung. Carp. **1**: 211. *pl. 4. f. 9.* 1861.

E. sanguisorbae DC. Fl. Fr. 6: 108. 1815; Duby, Bot. Gall. **2**: 868. 1830.

Alphitomorpha macularis Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 35 (partim). 1819; Wallr. Fl. Crypt. Germ. **2**: 756. 1833.

A. clandestina, var. *alchemillae* Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 36. 1819.

A. ferruginea Schlecht. Berl. Ges. Nat. Freund. Verh. **1**: 47. 1819.

A. aphanis Wallr. Ann. Wett. Ges. **4**: 242. 1819.

A. humuli Wallr. Ann. Wett. Ges. **4**: 243. 1819.

A. epilobii Wallr. Ann. Wett. Ges. **4**: 243. 1819.

Erysibe macularis, var. *humuli* Ficin. & Schub. Fl. Gegend. Dresd. **2**: 304. 1823.

E. macularis Schlecht. Fl. Berol. **2**: 168. 1824. Rabenh. Deutschl. Krypt. Fl. **1**: 231. 1844.

E. humuli Lk.; Willd. Sp. Pl. **6**: 101. 1824.

E. epilobii Lk.; Willd. Sp. Pl. **6**: 102. 1824.

E. fuliginea Lk.; Willd. Sp. Pl. **6**: 102 (partim). 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 230 (partim). 1844.

E. ferruginea (*poterii*) Lk.; Willd. Sp. Pl. **6**: 103. 1824.

E. aphanis Lk.; Willd. Sp. Pl. **6**: 104. 1824.

Erysiphe alchemillae Grev. Fl. Edin. 460. 1824.

E. macularis Fr. Syst. Myc. **3**: 237. 1829.

E. fuliginea Fr. Syst. Myc. **3**: 238 (partim). 1829.

E. ferruginea Fr. Syst. Myc. **3**: 238. 1829.

E. communis Fr. Syst. Myc. **3**: 239 (partim). 1829.

E. poterii Duby, Bot. Gall. **2**: 868. 1830.

E. alchemillae Duby, Bot. Gall. **2**: 870. 1830.

Erysibe alchemillae Desmaz. Pl. Cr. Fr. ser. 1, no. 517. 1831.

Alphitomorpha horridula, var. *spiraeacearum* and *dryadearum* Wallr. Fl. Crypt. Germ. **2**: 756. 1833.

Erysibe potentillae Lib. Pl. Crypt. Ard. fasc. 3, no. 279. 1834.

E. horridula Rabenh. Deutschl. Krypt. Fl. **1**: 235 (partim). 1844.

Erysiphe erodii Dur. & Mont. Fl. d'Algér. (Crypt.) 567 (excl. syn.). 1846–9; Mont. Syll. Crypt. 253. 1856; Sacc. Syll. Fung. **1**: 20. 1882.

E. glomerata Mér. Addit. Rev. Fl. Par. 497. 1847.

Sphaerotheca Castagnei Lév. Ann. Sci. Nat. III. **15**: 139. *pl. 6. f. 9, 10, 10'* (partim). 1851; Cooke, Micr. Fung. 218. *pl. 11. f.*

216 (partim). 1865; Cooke, Handb. Brit. Fung. **2**: 645. *f. 312* (partim). 1871; Karst. Myc. Fenn. **2**: 197 (syn. excl. partim). 1873; Sacc. Syll. Fung. **1**: 4 (partim). 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. 1^2: 27 (partim). 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 94 (partim). 1885; Jacz. Bull. l'Herb. Boiss. **4**: 725 (partim). 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 83 (partim). 1897.

Erysibe horridula, var. *ulmariae* Desmaz. Pl. Cr. Fr. ed. 1, n. 2196; ed. 2, n. 1846, and Ann. Sci. Nat. III. **18**: 370. 1852.

Erysiphe dipsacearum Tul. Sel. Fung. Carp. **1**: 210. *pl. 4. f. 4–8* (*syn. excl. partim*). 1861.

Podosphaera epilobii De Bary, Beitr. Morph. Phys. Pilze **1**: § xiii. 48. 1870.

Sphaerotheca pruinosa Cooke & Peck, Journ. of Bot. **1**: 11. 1872; Peck, Reg. Rep. **25**: 94. 1873; Sacc. Syll. Fung. **1**: 3. 1882; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 399. 1887; Burr.; Ell. & Everh. N. Amer. Pyren. 5: 1892.

S. Niesslii Thuem. Verh. k. k. zool.-bot. Gesell. Wien, **29**: 524. 1880; Sacc. Syll. Fung. **1**: 4. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. 1^2: 28. 1884.

S. epilobii (Lk.) Sacc. Syll. Fung. **1**: 4. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. 1^2: 27. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 95. 1885; Burr.; Ell. and Everh. N. Amer. Pyren. 8. 1892; Schroet.; Cohn's Krypt. Fl. Schles. **3**: 232. 1893.

S. fugax Penz. and Sacc. Att. R. Instit. Ven. VI. **2**: 10. 1884; Sacc. Syll. Fung. Addit. ad vol. I–IV: 1. 1886; and **9**: 365. 1891.

S. humuli (DC.) Burr. Bull. Ill. State Lab. Nat. Hist. **2**: 400. 1887; Burr; Ell. and Everh. N. Amer. Pyren. 5. 1892.

Albigo humuli "Ehrh." Steud., Kuntze, Revis. Gen. Plant. 3^2: 442. 1892.

A. epilobii (Lk.) Kuntze, Revis. Gen. Plant. 3^2: 442. 1892.

A. fugax (Penz. and Sacc.) Kuntze, Revis. Gen. Plant. 3^2: 442. 1892.

A. Niesslii (Thuem.) Kuntze, Revis. Gen. Plant. 3^2: 442. 1892.

A. pruinosa (Cke. and Peck) Kuntze, Revis. Gen. Plant. 3^2: 442. 1892.

S. humuli (DC.) Schroet.; Cohn's Krypt. Fl. Schles. **3**: 231 (partim). 1893.

EXSICC.: Klotzsch, Herb. Myc. 63, and spec. sub *Erysiphe communis*, var. *geranii*; Rehm. Ascom. 250; Cooke, Fung. Brit. Exsicc. 91; ed. sec. 590; Roumig. Fung. select. exsicc. 4840, 5622; Speg. Dec. Myc. Ital. 40; Rab. Fung. Eur. 557, 558, 1047, 1049, and 1430 sub *E. communis*; Syd. Myc. March. 1075, 2660, 2661, *3724, *4245; Sacc. Myc. Ven. 627, 628; de Thuem. Fung. Austr. 235, 443, 654, 755, and 1239 sub *E. communis*; de Thuem. Myc. univ. 960, 1540, and 2056 sub *E. lamprocarpa*; Fl. Exsicc. Austro-Hungar. 380; Westend. Herb. Crypt. Belg. 407, 829; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 165, 517, 1113, 1302, 1303, and 2196 sub *Erysibe horridula* ?, *ed. 2, ser. 1, 513, 702, 703, 812, 1846; Fckl. Fung. Rhen. 711, 712, 713, 718, 721, 2234, 2235; Oudem. Fung. Neerl. Exsicc. 72; Rab. Herb. Myc. ed. 2, 460, 468, and 481 sub *Erysibe horridula*; Roumeg. Fung. Gall. Exsicc. 640, and 3517, 3742, sub *E. communis*; Ayres, Myc. Brit.; Jack, Lein. and Stitzenb. Krypt. Bad. 633, 827; Lib. Pl. Crypt. Ard. fasc. 3, 279; and fasc. 4, 381; Rab.-Wint. Fung. Eur. 3041; Berk. Brit. Fung. 313, sub *Erysiphe communis*; Karst, Fung. Fenn. Exsicc. 278; Vize Fung. Brit. 91, sub *Sphaerotheca pannosa*; Rab.-Wint.-Patzsch. Fung. Eur. 3856; Erbar. Critt. Ital. ser. 1, 143, ser. 2, 1067; Ell. N. Amer. Fung. 557c; *Erikss. Fung. par. scand. 137a, 137b, 138, 234a, 234b; *Seym. and Earle, Econ. Fung. 278, 432, and 131a, sub *Sphaerotheca pannosa*; *Wartm. and Schenk, Schweiz. Krypt. 321; *Kneiff. and Hartm., Pl. Crypt. Bad. 158; *Cav. Fung. Long. Exsicc. 30; *Romell, Fung. exsicc. praes. scand. 60.

Amphigenous; mycelium usually evanescent, but sometimes persistent, and forming white orbicular spots or irregular patches on the upper surface of the leaf; perithecia usually somewhat gregarious, but varying from scattered to densely gregarious or even caespitose, 58–120 μ in diameter, cells small, averaging 15 μ wide, but varying from 10–20 μ wide; appendages very variable, few or numerous, usually long, often exceeding 9 times the diameter of the perithecium, more or less straight, septate and colored dark brown throughout, but sometimes short, tortuous, interwoven and pale brown, sometimes even obsolete, very rarely flexuose and more or less shining white throughout; ascus broadly elliptical

to subglobose, rarely shortly stalked, 45–90 × 50–72 μ; spores 8, 20–25 (rarely 30) × 12–18 μ, averaging 22 × 15 μ.

Hosts.—Agrimonia Eupatoria, Alchemilla arvensis, A. vulgaris, Collomia gracilis, C. heterophylla, C. linearis, Dipsacus laciniatus, D. sylvestris, Epilobium adenocaulon, E. alpinum, E. cephalostigma, E. coloratum, E. hirsutum, E. jucundum, E. montanum, E. palustre, E. parviflorum, E. parviflorum × roseum, E. pubescens, E. roseum, Erodium moschatum, Fragaria glauca, Geranium caespitosum, G. Carolinianum, G. Ibericum, G. incisum, G. maculatum, G. Nepalense, G. palustre, G. pratense, G. Richardsonii, G. sylvaticum, Geum album, G. Kokanicum, G. macrophyllum (265), *G. strictum, G. Virginianum, Gilia aristella, G. heterophylla, G. linearis, Humulus Japonicus, H. Lupulus, Morina persica, Neillia opulifolia, Phlox longifolia, Potentilla Anserina, P. bifurca, P. Comarum, P. fragarioides, P. glandulosa, P. palustris, P. reptans, P. Tormentilla, Poterium Canadense* and var. *medium, P. officinale* and var. *carneum, P. Sitchense* (cult.), *P. tenuifolium* and var. *album, Pyrus Aria, Rhus copallina, R. glabra, R. typhina* (60) (282), *Ribes floridum, Rosa Arkansana, R. blanda, R. lucida, R. Woodsii, Rubus Canadensis, R. hispidus, R. odoratus, R. spectabilis, R. strigosus* (60), *R. triflorus, Scabiosa Caucasica, Shepherdia argentea, S. Canadensis, Spiraea Aruncus, S. Camtschatica, S. salicifolia* (163), *S. Thunbergii, S. Ulmaria, Viola Canadensis, V. canina* var. *sylvestris.*

Distribution.—Europe: Britain, France, Spain and Portugal (77), Belgium, Netherlands, Switzerland, Italy, Germany, Austria-Hungary, Denmark, Norway, Sweden, Finland, Russia. Africa: Algeria. Asia: Transcaucasia (338), Turkestan, Siberia (Minussinsk), Japan. North America: United States—Maine (163), New Hampshire (124), Massachusetts, New York, Pennsylvania, New Jersey, Virginia, South Carolina, Ohio, Michigan, Indiana, Alabama (12), Tennessee, Illinois, Mississippi, Wisconsin, Missouri, Iowa, Minnesota, South Dakota, Nebraska, Montana, Wyoming, Colorado, Utah, California, Washington, Canada, Newfoundland, New Brunswick, Ontaria.

Var. **fuliginea** (Schlecht)

Alphitomorpha fuliginea Schlecht. Berl. Ges. Nat. Freund. Verh. **1**: 47. 1819.

Erysibe fuliginea Lk.; Willd. Sp. Pl. **6**: 102 (partim). 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 230 (partim). 1844.

Erysiphe fuliginea Fr. Syst. Myc. **3**: 238 (partim). 1829.

E. communis Fr. Syst. Myc. **3**: 239 (partim). 1829.

E. fusca Fr. Syst. Myc. **3**: 242. 1829.

E. lamprocarpa, var. *plantaginis* Duby, Bot. Gall. **2**: 869 (partim). 1830.

E. doronici Duby, Bot. Gall. **2**: 870. 1830.

Alphitomorpha lamprocarpa, var. *balsaminae* Wallr. Fl. Crypt. Germ. **2**: 758. 1833.

A. communis, var. *personatarum* Wallr. Fl. Crypt. Germ. **2**: 758 (partim). 1833.

A. fumosa Wallr. Fl. Crypt. Germ. **2**: 760 (syn. excl. partim). 1833.

Erysiphe gerardiae Schwein. Syn. Fung. Am. Bor. 269. 1834; Sacc. Syll. Fung. **1**: 22. 1882.

E. erigerontis Canadensis Lév.; Mér. Supp. Rev. Fl. Par. 459. 1843.

Erysibe lamprocarpa, var. *balsaminae* Rabenh. Deutschl. Krypt. Fl. **1**: 232. 1844.

E. communis Rabenh. Deutschl. Krypt. Fl. **1**: 232 (partim). 1844.

E. circumfusa Rabenh. Deutschl. Krypt. Fl. **1**: 232 (partim). 1844.

E. fusca Fr. Rabenh. Deutschl. Krypt. Fl. **1**: 235. 1844.

Erysiphe plantaginis Cast. Cat. Pl. Mars. 188. 1845.

E. xanthii Cast. Cat. Pl. Mars. 188. 1845.

Sphaerotheca Castagnei Lév. Ann. Sci. Nat. III. **15**: 139. *pl. 6. f. 9, 10, 10′* (partim). 1851; Cooke, Micr. Fung. 218. *pl. 11. f. 216* (partim). 1865; Cooke, Handb. Brit. Fung. **2**: 645. *f. 312* (partim). 1871; Syll. Fung. **1**: 4 (partim). 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 27 (partim). 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 94 (partim). 1885; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 400. *f. 3*. 1887; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 64. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 8. *pl. 1*. 1892; Jacz. Bull. l'Herb. Boiss. **4**: 725 (partim). 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 83 (partim). 1897.

Erysiphe detonsa Westend. (non Fr.) Bull. Acad. Roy. Belg. **18** : 403. *pl. 1. f. 3.* 1851.

Sphaerotheca detonsa Kickx. Fl. Crypt. Fland. **1** : 375. 1867. Lamb. Fl. Myc. Belg. **2** : 175. 1880; Sacc. Syll. Fung. **1** : 4. 1882; Oudem. Rev. Pyren. 11. 1884.

Podosphaera Castagnei (Lév.) de Bary, Beitr. Morph. Phys. Pilz. **1** : § xiii. 48. 1870.

Erysiphe fuscata Berk. & Curt. Grevillea, **4** : 159. 1876; Sacc. Syll. Fung. **1** : 19. 1882.

Sphaerotheca drabae Juel, Bot. Notis. 9. 1890; Sacc. Syll. Fung. **9** : 366. 1891; Juel, Bot. Centralbl. **45** : 274. 1891; Juel. Öfvers. K. Vet. Akad. Förh. (Stockholm), 496. 1895.

Meliola (*Meliopsis*) *calendulae* Malb. & Roum. Rev. Myc. **7** : 90. 1886.

Sphaerotheca calendulae (Malb. & Roum.) Malb. Bull. Soc. Myc. France, **4** : xxxii. 1888; Sacc. Syll. Fung. **9** : 366. 1891.

Albigo calendulae (Malbr. & Roum.) Kuntze, Revis. Gen. Plant. $\mathbf{3}^2$: 442. 1892.

A. drabae (Juel) Kuntze, Revis. Gen. Plant. $\mathbf{3}^2$: 442. 1892.

Sphaerotheca humuli (DC.) Schroet. in Cohn's Krypt. Fl. Schles. **3** : 231 (partim). 1893.

S. Castagnei, var. *submutica* Juel Öfvers. K. Vet. Akad. Förh. (Stockholm), **51** : 497. 1895.

S. erigerontis Oudem. Rév. Champ. Pays.-Bas. **2** : 84. 1897.

EXSICC.: Fckl. Fung. Rhen. 714, 715, 716, 717, 720, 722, 724, 1745, and 651 sub *Erysiphe lamprocarpa;* Rab. Fung. Eur. 1046, 1046b, 1050, 2026, 2414, and 580 sub *Sphaerotheca pannosa* Bon., and 1058, 2034 sub *Erysiphe lamprocarpa;* Westend. Herb. Crypt. Belg. 281, 555, 1056; and 972 sub *E. communis;* Rab. Herb. Myc. ed. 2. *459, 484 sub *Erysibe communis*, and 458 sub *E. lamprocarpa;* de Thuem. Myc. univ. 556, 1839; Syd. Myc. March. 194, 297, 833, 834, 1140, 1239, 1542; and 1639, sub *Erysiphe communis;* and 286 sub *E. lamprocarpa;* and 1147, *3719 sub *E. cichoracearum;* Roumeg. Fung. Gall. exsicc. 1537, 2168, 2657, 2741, 3658, 3739; and 1982, 1985 sub *E. communis;* Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 761 sub *Erysibe personatorum;* and 1304 (A only) sub *E. communis;* ser. 2, 673; Sacc.

Myc. Ven. 145, *630, 631, 632, 633, 629, 899, 1375, 1376, 900, 901; and 611 sub *Erysiphe lamprocarpa;* Kunze, Fung. select. exsicc. 574; Jack. Lein. & Stizenb. Krypt. Bad. 828; de Thuem. Fung. austr. 123, 442, 444, 653, 756; Oudem. Fung. Neerl. exsicc. 272; Speg. Dec. Myc. Ital. 83, 83 bis; Rehm. Ascom. 544, 545, 600, 750; and 450 sub? *E. communis;* Erbar. Critt. Ital. ser. 1, 878, ser 2, 1068; Rab.-Wint. Fung. Eur. 3657; Cooke, Fung. Brit. exsicc. ed. sec. 595 sub *E. lamprocarpa;* Kneiff. & Hortm. Pl. Crypt. Bad. 16; Ell. N. Amer. Fung. 557 a and b; *Seym. & Earle, Econ. Fung. 300a, 300b, 309, 325; Klotzsch Herb. Myc. 1745 sub *Erysibe communis* (in Herb. Mus. Florence); *Ell. & Everh. Fung. Columb. 311, 418, 504; *Krieg. Fung. Saxon. 577, 578, 722, 723; *Wartm. & Wint. Schweiz. Krypt. 725; *Erikss. Fung. par. scand. 290.

Perithecia usually smaller, sometimes only 50 μ in diameter; wall usually harder and more brittle, cells larger, irregularly shaped, averaging 25 μ wide, but varying from 20–30 μ, rarely 40 μ wide; appendages usually short, pale brown, tortuous and interwoven, but sometimes long, nearly straight, and dark brown; spores 20–25 × 12–15 μ.

HOSTS.—*Adenocaulon bicolor*, *Adenostyles albida*, *Ajuga ciliata*, *Arctium majus*, *Arnica cordifolia*, *A. montana*, *Astragalus alpinus*, *Bartsia Odontites*, *Bidens cernua*, *B. chrysanthemoides*, *B. connata*, *B. frondosa*, *B. tripartita*, *Calamintha Chinensis*, *Calendula arvensis*, *C. officinalis*, *Carpesium abrotanoides*, *Cnicus Weyrichii*, var. *Grayanum*, *Collomia linearis* (151), *Coreopsis aristosa*, *C. aurea* (265), *C. tripteris*, *Crepis paludosa*, *C. runcinata*, *Dimorphotheca fluvialis*, *Doronicum Austriacum*, *D. grandiflorum* (294), *Draba alpina*, var. *glacialis*, *D. hirta*, *D. incana*, *Erechtites praealta*, *Erigeron acris*, *E. annuus*, *E. Canadensis*, *Euphrasia officinalis*, *Fatoua pilosa*, var. *subcordata*, *Fragaria glauca* (151), *Gerardia grandiflora*, *G. quercifolia*, *Gaillardia aristata*, *Helianthemum vulgare*, *Hieracium* sp., *Hydrophyllum Virginicum*, *Impatiens noli-tangere*, *I. textori*, *Inula dysenterica*, *Lactuca brevirostris*, *L. Floridana* (97), *L. Raddiana*, *L. Sibirica*, *Leontodon autumnalis*, *Lophanthus anisatus*, *Melampyrum nemorosum*, *M. pratense*, *M. sylvaticum*, *Microseris aphantocarpha*, *Pedicularis cheilanthifolia*, *P. Groenlandica*, *P. lanceolata*, *P. pycnantha*, *P. resupinata*, *Phlox divaricata* (60), *Physalis Alkekengi*, *Plantago lanceolata*, *P. media*, *Prenanthes alba*

(97), *P. altissima* (60), *P. purpurea*, *Prunella vulgaris*, *Sanvitalia procumbens*, *Saxifraga rotundifolia*, *Scabiosa arvensis*, *Scrophularia canina*, *Senecio Cacatiastrum*, *S. cordatus*, *S. fluviatilis*, *S. Fuchsii*, *S. lugens*, *S. nemorensis*, *S. Sarracenicus*, *S. subalpinus*, *S. triangularis*, *Siegesbeckia orientalis*, *Taraxacum officinale*, *Tellima grandiflora*, *Thalictrum alpinum*, *Troximon glaucum*, *T. officinalis* (151), *Verbena* sp., *Vernonia Noveboracensis* (363), *Veronica longifolia*, *V. spartia*, *V. spicata*, *V. Virginica*, *Viola cucullata* (363), *Xanthium Canadense*, *X. Italicum*, *X. macrocarpum*, *X. spinosum*, *X. strumarium*.

Distribution.—EUROPE : Britain, France, Belgium, Netherlands, Switzerland, Italy, Germany, Austria-Hungary, Roumania, Denmark, Norway, Sweden, Finland, Russia.

ASIA : Turkestan, Siberia (Minussinsk), Japan.

NORTH AMERICA : United States—Maine, Massachusetts, New York, Pennsylvania, Maryland, New Jersey, West Virginia, (249), South Carolina, Ohio, Michigan, Indiana, Illinois, Alabama, Wisconsin, Missouri, Iowa, Minnesota, South Dakota (151), Montana, Wyoming, Colorado, California, Washington ; Canada, New Brunswick, Ontario.

Hosts recorded for the aggregate "*S. Castagnei* Lév." *Arabis alpina* (176), *Aster Bellidiastrum* (3), *Caltha palustris* (230), *Carlina vulgaris* (261) (290), *Cichorium Intybus* (214), *Crepis tectorum* (319), *Cucumis sativus* (22) (132) (133) (345) (377), *Cucurbita* (55) (132) (133) (176) (209) (214) (271), *C. maxima* (68), *C. Pepo* (22) (377) (390), *Dipsacus fullonum* (272), *Epilobium angustifolium* (391), *E. tetragonum* (319), *Eupatorium cannabinum* (209) (214), *Geranium dissectum* (176), *G. molle* (205*), *Heuchera parvifolia* (6), *Hieracium sabaudum* (214) *Impatiens Balsimina* (43), *Lapsana communis* (272) (319), *Linaria vulgaris* (107), *Lycium ovatum* (319), *Pedicularis foliosa* (290), *Pentstemon barbatus* (107), *Plantago major* (390 and 391), *Platanus occidentalis* (22) (296), *Potentilla approximata* (235), *P. Pennsylvanica* (347), *Poterium Sanguisorba* (214) (229) (230), *Rhinanthus angustifolius* (319), *R. minor* (3), *Saxifraga punctata* (311), *Scabiosa integrifolia* (214) *Scorzonera* sp. (349), *S. radians* (235), *Senecio Jacobaea* (319), *S. lyratifolius* (3), *S. spathulaefolius* (176), *S. sylvaticus* (22) (344) (345), *S. vulgaris* (230) (263) (353), *Spiraea filipendula* (58),

Thalictrum simplex (348), *Thelesperma filifolium* (288), *Trifolium* (204) (209), *Urtica* (177), *Vitis vinifera* (22).

Burrill (61) was the first to point out that the old "*Sphaerotheca Castagnei* Lév." was an aggregate species, comprising two sets of forms on different host plants which show constant differences in the size of the cells of the outer perithetical wall. Relying on this character, and on others mentioned below, Burrill divided "*S. Castagnei* Lév." into two species. *S. humuli* and *S. Castagnei*. These two plants I have described above under the names of *S. humuli* and its variety *fuliginea*, as from the study of a large amount of material I feel convinced that the two are not specifically distinct.

To separate the two forms as species, Burrill relied on differences in these characters : the size of the cells of the outer perithecial wall, the nature of the appendages, and the size of the spores. *S. humuli* is stated to have cells usually less than 15 μ wide, appendages slender, 3 or more times as long as the diameter of the perithecium, usually colored throughout when mature, mostly free from the mycelium, and spores averaging 20 μ long ; *S. Castagnei*, cells 20–30 μ wide, appendages long, stout, usually colored throughout, but sometimes colorless, flexuous, somewhat uneven in width, more or less interwoven with the mycelium, and spores small, about 15 μ long.

The difference in the average size of the cells of the outer wall of the perithecium, here pointed out, is certainly found, but, at the same time, is not quite so sharply defined. In *S. humuli* I have found the cells to vary from 10–20 μ in width, occasionally a single cell may measure 25–28 μ, but the average width may be stated as about 15 μ ; in the var. *fuliginea* the cells are much more irregular in shape and measure, from 20–30 μ wide, occasionally reaching to 40 μ (it may be noted that the larger size and the irregularity in shape of each cell is often seen to be caused by the absence of a wall, which is sometimes clearly indicated) across the middle. Occasionally, the cells in the var. *fuliginea* are not wider than 20–25 μ, and very rarely, indeed, as, *e. g.*, in the specimen in Sacc. Myc. Ven. 1376, we find here and there a few cells as narrow as 15 μ—in fact, in this example, the cells have a range of 15–25, or rarely 30 μ in width. On the other hand, in

a few forms of *S. humuli*, *e. g.*, specimens on *Geum album*, the cells here and there become largely and slightly irregular in shape, and I have found contiguous cells to measure 10 μ and 28 μ wide, although in the specimen in question the cells averaged under 20 μ. Nevertheless, on the whole, with the few and rare exceptions noted above, the difference in the size of the cells is constant and strongly marked, so that there is usually no difficulty in referring at once any specimen, by means of this character, to either *S. humuli* or its var. *fuliginea*. The difference can be well seen by comparing together the two commonest examples of these plants, viz, *S. humuli* on the hop, with *S. humuli*, var. *fuliginea* on the dandelion.

I do not find the other separative characters put forward by Burrill to hold good. Identically formed appendages are found in certain examples of the two plants, and we can only say that as a rule *S. humuli* has longer, straighter, darker colored appendages, while in the var. *fuliginea* they are, as a rule, shorter, paler, and more tortuous. But to this rule there are certainly numerous exceptions, and we find forms of *S. humuli*, *e. g.*, on *Geum album*, *Rubus*, *Gilia linearis*, *Geranium*, etc., which have appendages identical in all respects with those usually characteristic of the var. *fuliginea*, from which these examples can be separated only by the small size of the cells of the perithecium. Similarly, certain forms of the var. *fuliginea*, *e. g.*, those on *Microseris tenella*, *Senecio lugens*, etc., have long, deeply colored appendages, very closely approaching those of typical *S. humuli*.

The size of the ripe spores in the two plants is difficult to ascertain, as the spores are formed very tardily, and in many of the most interesting specimens it is frequently the case that no ripe spores are to be found. As far as I have been able to observe, however, the difference in size given by Burrill does not appear to be constant; certainly the spores of the var. *fuliginea* often much exceed the length given by this author, viz, 15 μ; in the specimen in Syd. Myc. March. 297 (on *Veronica longifolia*) they frequently measure 25 μ long.

There remains, therefore, only the difference in the size of the perithecium, and this, while affording a fairly reliable character, cannot, I think, be considered as one of more than varietal importance.

A few words of explanation are necessary in connection with the names here adopted for the two plants. *Erysiphe humuli* DC. (1815), being the oldest name of either of the two, must stand as the specific name of the plant here considered the type and called *S. humuli* (DC.) Burrill. The other plant has, as already mentioned, been called *S. Castagnei* Lév. by Burrill, but this name cannot be retained, and the oldest name *Alphitomorpha fuliginea* Schlecht. (1819) must be adopted in its place. It is true that in Schlechtendal's description the large cells of the perithecium, which form the essential character of the variety, are not mentioned, so that the identity is established solely by means of the host-plant (*Veronica*) given. As, however, we know that on this host it is exclusively the large-celled form which occurs we can safely adopt the name *fulginea*—just as has been already done in fact, in the similar case of "*Erysiphe humuli*" on the hop.

A form of *S. humuli* which occurs on *Pyrus Aria* has been described as a distinct species by de Thuemen under the name of *S. Niesslii.* The separative characters relied upon were the smaller perithecium and ascus, and especially the scattered habit of the plant. In examining a large series of *S. humuli*, however, it is seen that the characters given cannot be considered distinctive of the form on *Pyrus Aria* alone as we find examples on many other hosts, *e. g.*, on *Potentilla*, in which exactly the same habit is found. In specimens on *Potentilla*, just as in "*S. Niesslii*" on *Pyrus Aria*, the appendages of the perithecium tend to become obsolete, perhaps owing to the densely tomentose surface of the host-leaf in both cases. The perithecia of "*S. Niesslii*" that I have examined average 60 μ in diameter (de Thuemen stated the average to be 86 μ). This is rather below the usual size for *S. humuli*, but perithecia of the same size do occur on *Potentilla* and other hosts, with asci o, as small a size as that given for "*S. Niesslii.*" It may be noted too, that in *S. humuli* var. *fuliginea* perithecia with a diameter of only 50 μ occur. On the whole, "*S. Niesslii*" cannot be regarded as anything more than a small form of *S. humuli.*

E. epilobii is identical with certain forms of *S. humuli.* No sufficient distinguishing characters have been given in any diagnosis of this form, and it is evident that, as a general rule, specimens have been referred to "*S. epilobii*" merely from their occurrence on species of *Epilobium.*

Erysiphe erodii was the name given by Durieu and Montagne in 1846–9, to a fungus occurring on *Erodium moschatum* at Oran, Algeria. In their account of the plant, the authors described the perithecium as containing many asci. In 1851 Léveillé identified "*E. erodii*" with *Sphaerotheca Castagnei.* The correctness of this identification has since been questioned by Montagne and also by Saccardo ("Asci plures, ergo non *Sphaerotheca*"). An examination of the original Algerian specimens, however, confirms Léveillé's determination, and shows the fungus to agree in all characters with *S. humuli.*

Professor Penzig kindly sent me for examination the type specimen of *S. fugax* Penz. and Sacc. on *Geranium sylvaticum.* The fungus shows these characters: perithecia 80–98 μ in diameter; cells 15–20 μ wide, appendages long, up to 7 times the diameter of the perithecium, colored pale brown for most of their length, ascus 80–95 × 65–75 μ, spores 20–22 × 13–15 μ. I cannot, in fact, find that the plant differs in any way from *S. humuli*, which occurs frequently on species of *Geranium.*

S. drabae Juel is certainly to be referred to *S. humuli* var. *fuliginea*, and the same is the case with the *S. Castagnei*, var. *submutica* of the same author. I am indebted to Professor Juel for specimens (now in the Kew Herbarium) of both these forms. In the original diagnosis, *S. drabae* (on *Draba hirta*) is described as having no appendages, and in a later description, where the plant is recorded as occurring on *Draba incana*, *Astragalus alpinus*, and *Thalictrum alpinum* Juel (186) remarks "Rostrup hat einen Zweifel aber den Wert dieser art ausgesprochen (Bidr. Kundsk. Norges Sopart II. Christiania Vid.-Selsk. Forhandl., 1891) und vermutet dass dieselbe von *Sph. Castagnei* nicht verschieden sei. Bei *Sph. drabae* sind die Perithecien nur am Grunde durch einige Hyphen mit dem Mycel verbunden, aber entbehren gänzlich der Anhängsel." In the numerous specimens of *S. drabae* sent to me, however, I find, as a rule, a few short, pale brown, tortuous appendages on the perithecium, and rarely the appendages are even numerous. In the characters of the appendages, and in the large perithecial cells, the specimens agree perfectly with *S. humuli* var. *fuliginea.* "*S. Castagnei* var. *submutica*" is the ordinary form of the var. *fuliginea* on species of *Melampyrum.*

A species of *Sphaerotheca* was published as *S. pruinosa* by Cooke and Peck, in 1872, with the following diagnosis: "Amphigenous. Mycelium effused, arachnoid, subpersistent. Conceptacles minute, globose, scattered. Appendages few, interwoven, colorless.—On both surfaces of leaves of *Rhus glabra*, Albany, New York. Habit and character of mycelium very distinct from *S. pannosa*. The colorless appendages will not permit of its being confounded with *S. Castagnei*. Sporidia .0007–.0008 in. × .0004 in." Examination of the type specimens on *Rhus glabra*, and of others on *R. copallina*, shows the fungus to possess these characters: mycelium persistent, thin, and effused, perithecia more or less scattered, 70–105 μ in diameter, cells small, 8–15 μ wide; appendages rather few, variable in length, sometimes 6 times the diameter of the perithecium, usually shorter, more or less flexuous or angularly curved, usually more or less refractive and shining white throughout, with the lumen obliterated, sometimes brownish at base, very rarely pale brown nearly to the apex; ascus elliptic-oblong to subglobose, 70–90 $\mu \times$ 50–65 μ, spores 8, 22–25 $\times$ 12–15 μ.

As Cooke remarks, the habit and mycelial characters separate the plant from *S. pannosa*, and the affinity is certainly wholly with *S. humuli*, to which species, indeed, I have felt obliged, for the reasons given below, to unite this form on *Rhus*. When investigating the so-called "*S. pannosa*" of many American mycologists I was at once struck by the resemblance of some specimens of this fungus on Rose-leaves to "*S. pruinosa*." In the first specimen examined, "on cult. roses, Madison, Wis., 1880 (Henry)" (in the Herbarium of the Missouri Botanic Garden), the resemblance was so close that there could be no doubt that the fungus on *Rhus* and this on *Rosa* belonged to the same species. At that time I thought it might be possible, relying on the white shining appendages to keep the plant distinct from *S. humuli*. Since then, however, I have seen more material of this fungus on American roses. For this I am indebted chiefly to Professor Seymour and Professor Clinton, and the specimens sent (now in the Kew Herbarium) show clearly that although this fungus on *Rosa* has in many examples, quite colorless appendages like those of "*S. pruinosa*," in others it may show distinctly colored appendages,

and become indistinguishable from certain forms of *S. humuli*. Evidence on another side also points to "*S. pruinosa*" being only a form of *S. humuli*. The form of *S. humuli* on *Geranium sylvaticum* published by Penzig and Saccardo as "*S. fugax*" is described as having appendages "hyalinae vel basi dilute fuligineae," and it was probably on account of this character that the authors considered their plant as showing affinity with *S. pruinosa*. Although in the type-specimen of "*S. fugax*" the perithecia I examined showed more or less colored appendages, other examples that I have seen of *S. humuli* on species of *Geranium* have had appendages colorless and shining in the upper half quite agreeing in all respects with certain specimens on *Rosa* from America.

It may be objected that as *S. humuli* already contains so many forms which differ in slight characters (*e. g.*, the scattered or clustered habit, a persistent or evanescent mycelium, long or very short or even rudimentary appendages) it is inadvisable to include under the name a form with shining white appendages. But if we were to separate by means of this character, the plant on *Rhus* as even a variety of *S. humuli*, we should have to recognize, it seems to me, very arbitrary and unnatural limits. In the first place, with regard to the specimens on *Rhus*, the occasional occurrence of color in the appendages would have to be overlooked; certain, if not all, specimens on American roses (referred to above) would have to be included in the variety, although forms on species of *Geranium* would be found to completely connect them to the type. It seems more natural, I think, to regard "*S. pruinosa*" as only a form of *S. humuli*. We may perhaps regard this white appendaged plant on *Rhus* together with certain specimens on *Rosa*, as a marked form developing into a new species, but at the present time too closely connected by intermediates to be separated systematically.

Halsted (156) records the occurrence of *S. pruinosa* on *Phytoptus* distortions on the inflorescence of *Rhus glabra*.

S. calendulae (Malb. & Roumeg.), on *Calendula arvensis* is *S. humuli*, var. *fuliginea*; the asci contain eight spores not six as described. Fuckel records a fungus, observed only in the conidial stage on *Rubus Idaeus*, under the name of *Erysiphe ? rubi* (Symb.

Myc. 86, Wint. in Rabenh. Krypt. Fl. Deutschl. 1^2: 34. It is probable that this fungus is *S. humuli*, as this species occurs on several American species of *Rubus*. The record of "*S. Castagnei*" on the vine probably rests merely on the occurrence of "*Oidium Tuckeri*" on the plant, as the latter was supposed by Fuckel and others, to be a conidial form of "*S. Castagnei*."

S. humuli, when it occurs on hops, is well-known as "hop mildew," a disease which causes serious injury in hop-gardens. On the leaves, the fungus does not occasion much damage, probably only slightly weakening the vitality of the host-plant, but when it occurs on the cones it materially injures their quality, and in severe attacks causes them to completely shrivel up. The "hop mildew," although recorded on cultivated hops on the Continent in many places, does not apparently cause so much damage there as in England, where it is one of the most dreaded diseases of the hop-grower. In the United States, also, although Burrill (60, p. 6) says that *S. humuli* "is a very destructive parasite, especially on cultivated hops" the disease would appear, judging from the absence of any reports (which have been so much made by American mycologists on other plant-diseases) to be less prevalent or less severe than in English hop-gardens. As in the vine powdery mildew, sulphur has been found to be an efficacious remedy. The best results have followed from the use of flowers of sulphur applied during sunshine. For full details of the preparation and application of the sulphur reference may be made to the papers of Whitehead (392, 393) on the subject.

I cannot confirm the statement made in the Journal of the Board of Agriculture for 1897 (181) that in hop-cones infected by *S. humuli* the mycelial hyphae penetrate into the epidermal cells of the bracts, as in material examined I have found within these cells only the usual haustoria.

Whitehead (393, p. 247) recommends as a preventive method against the hop-mildew the removal of all other plants which are the hosts of the fungus from the hop-gardens, and mentions especially *Taraxacum*, *Senecio vulgaris* and other Composites, and *Plantago*. These host-plants of the old aggregate species "*S. Castagnei*" all belong, however, to the form now separated as *S. humuli*, var. *fuliginea*, while the hop-mildew is caused by the type

S. humuli. The weeds that should be destroyed in English hop-gardens are those which are known to be the hosts of *S. humuli*, viz: *Agrimonia Eupatoria*, *Alchemilla arvensis*, *Dipsacus sylvestris*, species of *Epilobium*, *Geranium*, and *Potentilla*, and *Spiraea Ulmaria*.

We are, however, at present, quite ignorant as to how far any form of a mildew is capable of spreading from one host to another. There is also the question—a most important one for systematists—of the influence of the host-plant upon its parasite. The experimental work necessary to answer these two questions is almost entirely wanting. Magnus (227, p. 68), however, records the following extremely interesting facts: "Ueber die Frage, ob die parasitischen Erysipheen von einer Nährpflanzenart leicht auf eine Art übergehen, sind mir keine Versuche bekannt. Ich selbst habe einen einzigen hierhingehörigen Versuch mit Erfolg aufgestellt. Es war mir auffallend dass *Sphaerotheca Castagnei* Lév. auf zwei so verschiedenen Wirthspflanzen wie *Humulus Lupulus* and *Taraxacum officinale* auftreten sollte, zwei Wirthspflanzen, die ebenso verschieden sind nach ihrer systematischen Verwandlschaft, wie nach der physikalischen Beschaffenheit der Oberfläche ihres Laubes, wie nach ihrer chemischen Beschaffenheit. Ich nahm Anfang Juli 1896 Blätter von *Humulus Lupulus*, die mit dem *Oidium* befallen waren, und legte sie auf die Blätter eines pilzfreien *Taraxacum*. Am 27 Juli zeigten sich auf den Blättern des *Taraxacum* zahlreiche scharf umschriebene Rasen des *Oidium*, and zwar nur auf den Blättern des *Taraxacum*, die ich mit den Mehlthau tragenden Hopfenblättern belegt hatte." Later, Magnus (230), noticing that the two forms on *Humulus* and *Taraxacum* had been considered as distinct species by Burrill, thus commented on his experiment: "Nur möchte ich bemerken, dass ich mit Erfolg das *Oidium* von *Humulus Lupulus* auf *Taraxacum officinale* geimpft habe. Dies braucht nicht zu widersprechen der Auschauung, dass meistens auf Compositen und auf *Humulus Lupulus* verschiedene *Sphaerotheca*-Arten auftren, da recht gut so wohl auf dem Hopfen (auf dem ich selbst *Sphaerotheca humuli* (DC.) und *Phyllactinia suffulta* (Rebent.) Sacc. bemerkt habe und auf dem Burrill (N. Amer. Pyren.) noch *Erysiphe cichoracearum* DC. angiebt), als auch auf *Taraxacum officinale* zwei nahe verwandte Sphaerothecen gedeihen könnten."

Magnus' experiment is valuable in showing that the conidia of *S. humuli* will germinate and produce a conidia-bearing mycelium when shown on a house plant upon which (it is almost safe to say) the ascigerous stage never occurs in nature. Unfortunately, the experiment was not continued long enough to ascertain whether perithecia would be produced. It is possible that the fungus would not have been capable of producing these on the unusual host-plant. This supposition would explain the fact of *S. humuli* never having been recorded on *Taraxacum*, although in nature its conidia may frequently germinate upon this extremely common plant. On the other hand, it is possible that the conidia of *S. humuli* might have ultimately produced upon the *Taraxacum* the large-celled perithecia which we at present consider distinctive of the var. *fuliginea* (which is very common on *Taraxacum*); in other words, it is possible that the difference in size of the cells of the perithecial wall is due to the effect of certain different host-plants on the same species of a parasitic fungus. We know that in some forms of certain species of the Erysiphaceae, characters to which even specific value has been given are directly correlated with the occurrence of the fungus on a certain host-plant—"*Microsphaera pulchra*" on *Cornus alternifolia* affords a good instance. In this plant which is now allowed by all mycologists to be only a form of *M. alni*, a characteristic and more elaborate branching of the apex of the appendages is connected with the occurrence on *Cornus*; in the case of *S. humuli* a similar correlation may exist between the size of the cells, of the perithecium and the host-plant.

S. humuli, in addition to causing the hop-disease, sometimes seriously attacks cultivated strawberries. In America the disease is known as the "strawberry mildew," and is stated (8) to attack the fruit (both ripe and unripe) and fruit-stalks, as well as the leaves of strawberries. The fungicide recommended is a mixture composed of a quarter of an ounce of sulphide of potassium in a gallon of water; or, according to Humphrey (169), a preparation made as follows: one ounce of carbonate of copper, mixed with five ounces of carbonate of ammonia, and dissolved in a quart of hot water; when dissolved, sixteen gallons of water are added.

In the Journal of the Board of Agriculture for 1898 (183) a

disease is described which seriously affected some English strawberries during that year. Its attacks are described as follows: "This disease makes its appearance in May, in the form of white spots upon the leaves. These gradually spread and cover the leaf surfaces and extend to the fruit, covering it with white filaments, which may easily be mistaken for common mould. * * It is most rapid and destructive in its action as the fruit approaches ripeness. As in the case of the allied hop-mildew, which "runs" with great rapidity in the hop-cones as they approach maturity, the full virulence of the strawberry mildew is concentrated upon the ripening fruit, so that the latter is spoiled before it is fit to pick." The fungus causing this disease is here identified as *S.phaerotheca pannosa*, but it is most probable that *S. humuli* was really the species that occurred. The description given of the fungus is rather unsatisfactory (*e. g.*, the perithecia are stated to contain several asci); the figures of the perithecium, however—one of which shows a perithecium in section with a single ascus—represent *S. humuli* fairly well. It is recommended that imperfect strawberry plants should be sprayed either with "a weak Bordeaux mixture, composed of 4 lbs. of sulphate of copper and 3 lbs. of lime to 50 gallons of water, or with a composition of 2 lbs. of sulphide of potassium (liver of sulphur) to 50 gallons of water."

S. humuli illustrates in a striking manner the impossibility of placing any systematic value on the position or the scattered or clustered habit of the perithecia. On *Pyrus Aria*, *Potentilla argentea*, etc., the perithecia are uniformly and distantly scattered over the lower surface of the leaf; on perhaps the majority of the host-plants they are more or less gregarious, often on both sides of the leaf, but frequently only on the upper surface, or commonly they occur on the stem; on *Gilia linearis*, etc., the perithecia are closely crowded into dense patches on different parts of the plant, while on *Neillia opulifolia*, and in a few other cases, they are so densely caespitose that they more or less encrust in places considerable portions of the stem, petiole, etc.

Professor Selby has sent me a plant (now in the Kew Herbarium) on *Shepherdia Canadensis* from Michigan, U. S. A., under the MSS. name of *Sphaerotheca shepherdiae*. The distinctive characters were considered to be the crowded habit of the small peri-

thecia which here and there form black masses on the stem, and the rudimentary appendages. After a careful examination of the specimens sent I am quite unable to separate the fungus from *S. humuli*, and feel convinced that it is only one of the many forms of this species, and that the slight characteristics which it presents (which are not, however, confined to the fungus on *Shepherdia*) may be regarded as probably due in this case, to the position of the fungus among the densely arranged peltate scales of the stem of the host-plant. Griffiths (151) records *S. humuli*, var. *fuliginea* on *Shepherdia argentea* and *S. Canadensis*, and Burrill (60) the same on *S. argentea;* probably in both cases the fungus is the one above referred to *S. humuli.*

Except in America, *S. humuli* has not hitherto been distinguished from the var. *fuliginea*, and the European host-plants, as far as I have been able to see specimens of the fungus on them, are here for the first time separated under the two forms. The fungus recorded on host-plants which I have not seen I have been obliged to leave under the aggregate species, " *S. Castagnei* Lev." Many of these hosts, *e. g.*, species of *Epilobium*, *Potentilla*, etc., might probably be safely considered those of *S. humuli;* others, *e. g.*, species of *Senecio*, *Impatiens*, *Balsamina*, etc., as belonging to the var. *fuliginea.*

Although so many authors have referred the fungus on *Cucurbita* and *Cucumis* to " *S. Castagnei*," it seems very probable that a mistake has been made in the identification, and that the fungus in question is an *Erysiphe.* In the first place, although one finds in herbaria very numerous examples of a fungus in the conidial (*Oidium*) stage on leaves of *Cucurbita* and *Cucumis* referred to *S. Castagnei*, in my experience no specimens in the perithecial stage are to be found in herbaria on these hosts. It is evident, therefore, that for some reason it has been the practice among mycologists to name any *Oidium* on *Cucurbita* and *Cucumis*, *S. Castagnei* Lév. There can be no doubt also that this fungus on cucurbitaceous plants is extremely slow in producing perithecia, and the only example I have seen in this condition was gathered in the late summer at Reigate, England, in 1898. This, as already mentioned, proved to be *Erysiphe cichoracearum.*

The practice of referring a fungus in its *Oidium* stage to a

certain species of the Erysiphaceae has led, I feel convinced, to very numerous mistakes, and has made any compilation of a host-index from published records alone utterly misleading.

Further, not only are wrong host-plants for a certain species thus given, but as a natural consequence our knowledge of the geographical distribution of the species in question becomes erroneous. For instance, Winter (111) records the occurrence of "*Sphaerotheca Castagnei*" "in foliis *Cucurbitacearum*" from the island of St. Thomas, Africa, an occurrence extremely interesting not only geographically, but also climatically, as the island is on the equator. In the present confusion it is impossible to say whether the fungus was really "*S. Castagnei*" in a perithecial stage, or, whether, as is more probable, it was not merely an *Oidium* which had been referred to *S. Castagnei* in accordance with the usual custom.

The fungus recorded as "*S. Castaguei*" on apples proves to be *Podosphaera leucotricha*; the records of the present species on *Trifolium* and *Urtica* probably belong to *Erysiphe polygoni*.

2. S. PANNOSA (Wallr.) Lév.

Alphitomorpha pannosa Wallr. Berl. Ges. Nat. Freund. Verh. **1** : 43. 1819; Wallr. Fl. Crypt. Germ. **2** : 760. 1833.

Eurotium Rosarum Grev. Scot. Crypt. Fl. **3** : *pl. 164. f. 2.* 1823, and **6** : Synops. 7, 1826.

Erysibe pannosa Schlecht. Fl. Berol. **2** : 170. 1824; Lk.; Willd. Sp. Pl. **6** : 104. 1824; Rabenh. Deutschl. Crypt.-Fl. **1** : 230. 1844.

Erysiphe pannosa Fr. Syst. Myc. **3** : 236. 1829; Duby, Bot. Gall. **2** : 869. 1830; Berk. in Sm. Engl. Fl. **5** : 325. 1836; Tul. Sel. Fung. Carp. **1** : 208. *pl. 4. f. 1–3.* 1861.

Sphaerotheca pannosa Lév. Ann. Sci. Nat. III. **15** : 138. *pl. 6. f. 8.* 1851; Cooke, Micr. Fung. 218. *pl. 11. f. 217, 218.* 1865; Cooke, Handb. Brit. Fung. **2** : 645. 1871; Sacc. Syll. Fung. **1** : 3. 1882; Wint. Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 26. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2** : 94. 1885; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2** : 398 (*partim*). 1887; Cooke, Handb. Austral. Fung. 313. *pl. 25. f. 239.* 1892; Burr.; Ell. and Everh. N. Amer. Pyren. 6 (*partim*). 1892; Schroet.; Cohn's Krypt. Fl.

Schles. **3** : 230. 1893 ; Jacz. Bull. l'Herb. Boiss. **4** : 726. 1896 ; Oudem. Rév. Champ. Pays-Bas. **2** : 82. 1897.

Podosphaera pannosa de Bary, Beitr. Morph. Phys. Pilz. **1** : § xiii., 48. 1870.

Albigo pannosa (Wallr.) Kuntze, Revis. Gen. Plant. 3^2 : 442. 1892.

EXSICC.: Desmaz. Pl. Cr. Fr. ed. 1 : ser. 1 : 404 ; Baxt. Stirp. Crypt. Oxon. fasc. 2 : 92 ; Lib. Pl. Crypt. Ard. fasc. 1 : 80 : Cooke, Fung. Brit. Exsicc. 90, ed. sec. 589 ; Rab. Fung. Eur. 2214 ; Rehm. Ascom. 796 ; Fckl. Fung. Rhen. 725 ; Berk. Brit. Fung. 96 ; * Rab. Herb. Myc. ed. 2 : 459 ; Wahrlich. Parasit. Pilze. 31 (in Herb. Hort. Imp. Petropol.) ; * Syd. Myc. March. 4514 ; * Erikss. Fung. par. scand. 33 ; * Seym. & Earle, Econ. Fung. 131b.

Mycelium persistent, forming on the stem, calyx, petiole, and rarely on the midrib at the back of the leaf, dense satiny patches, at first shining white, but often becoming gray, dingy buff, or rarely pale brown, composed of densely interwoven special hyphae, which are about 6 μ wide, sparingly branched, somewhat rigid, refractive and thick-walled, with the lumen becoming obliterated ; perithecia more or less (usually completely) immersed in the persistent mycelium, globose to distinctly pyriform, 85–120 μ in diameter, usually about 100 μ, cells obscure, about 10 μ wide ; appendages few, often obsolete, very short, tortuous, pale brown, septate ; ascus broadly oblong to globose, 88–115 μ, averaging 100×60–$75\ \mu$; spores 8, 20–27×12–$15\ \mu$.

Hosts.—Prunus Persica, Rosa alba (95), *R. arvensis, R. canina, R. centifolia, R. cinnamomea* (99), *R. damascena, R. dumetorum* (319), *R. Eglanteria* (290), *R. Gallica, R. glauca* (319), *R. pomifera, R. rubiginosa* (319), *R. tomentosa, R. villosa.*

Distribution. — EUROPE. — Britain, France, Portugal (395), Spain (—), Belgium (14) (209), Netherlands (1), Switzerland (176), Italy, Germany, Austria-Hungary (20) (43) (95), Denmark, Norway, Sweden, Russia.

ASIA —Cyprus, Transcaucasia (338), India (85).

AUSTRALIA.—Queensland (89), Victoria, New South Wales and Queensland (225).

NORTH AMERICA.—United States : Tennessee, Illinois (probably in many other states, but has been generally confused with *S. humuli*).

[W. INDIES.—Jamaica (76).]

[SOUTH AMERICA.—Quito, Ecuador (275).]

The present species is sharply marked off from all the species of the *Erysiphaceae* by its pannose satiny patches of persistent mycelium, in which the perithecia are usually completely immersed. Under the microscope these patches are seen to be composed of special hyphal branches from the ordinary vegetative mycelium, about 6 μ wide, somewhat rigid, more or less straight, sparingly branched, with numerous free, somewhat tapering ends. The hyphae are thick-walled, becoming more or less solid at maturity through the obliteration of the lumen, and are shining white and refractive, so that each hypha has somewhat the appearance of a solid glass rod. Among these densely interwoven hyphae the perithecia are produced. These are interesting in being sometimes distinctly pear-shaped; the appendages are short, or quite rudimentary.

Although *S. pannosa* in its *Oidium*-stage (*O. leucoconium* Desmaz.) often covers the upper surface of rose-leaves, I have not been able to find, in the considerable amount of material examined, any perithecia formed here. It is only rarely, indeed, that perithecia are formed on the leaves at all (the stem usually being chosen), and then it is always in the characteristic pannose patches on the petiole or at the back of the midrib, and not scattered over the surface.

It has frequently been asserted that the mycelium of *S. pannosa* is perennial, and reappears in successive years on the same shoots of infected roses, and it has been supposed by many authors that the mycelium is capable of entering at times into the tissues of the host-plant, although no direct evidence exists, apparently, to support this view (*cf.* Winter (394, p. 26) and Schroeter (319, p. 230) where the author remarks: Dieser Pilz kann auf den befallenen Stöcken überwintern und wird selbst durch Pfropfreiser übertragen"). In the examination of shoots of rose-bushes covered with patches of *S. pannosa* in different stages of development, I have found only the usual haustoria in the epidermal cells, and no signs of an internal mycelium. It was noticeable, too, in the specimens examined that the fresh centers of disease which appeared in the spring did not occur at the places (marked by con-

spicuous scars or the nearly black and decaying remains of the old persistent mycelium) where the fungus grew in the previous year. Eriksson remarks on the subject (119): "Die bei diesem Pilze vorhandenen Perithecien scheinen übrigens nicht für sich allein das Fortleben des Mehlthaues in dem Grade wie er dem Gärtner jetzt bekannt ist, genügend zu erklären, besonders wenn man an die in den Gewächshäusern so verheerende, so weil bekannt nie perithecienführende Form der Krankheit denkt. Ihre dortige Lebenskräftigkeit muss unzweifelhaft auf andere Ueberwinterungsweisen, z. B. auf ein unter günstigen Umständen in die peripherischen Gewebe der Nährpflanze eindringendes und da fortlebendes Mycelium, auf ein saprophytisches, hefepilzänhliches Entwicklungsstadium des Pilzes im Sinne Brefeld's oder dgl. zurückgeführt werden. Mikroskopische Beweise für die eine oder andere Annahme sind jedoch noch nich gebracht worden."

In Europe *S. pannosa* is not uncommon, indeed in its *Oidium*-stage it is very frequent, on wild and cultivated roses, although perithecia are produced less commonly. From Asia (Cyprus) Professor Gennardius has sent me specimens on *Rosa damascena*, which are identical with European examples. Cooke (85) states that in India roses suffer the attacks of *S. pannosa* in the same way as they do in Europe; and in the same author's work on Australian fungi (89) *S. pannosa* is recorded (an unsatisfactory figure is given) "on rose-leaves" from Queensland.

How far these records and those of *S. pannosa* from the West Indies and South America rest on the occurrence of an *Oidium*-stage on rose-leaves, identified as that of *S. pannosa* merely from growing on this host-plant, it is impossible to say. The prevalent practice of naming species of the *Erysiphaceae* in the conidial stage cannot be too strongly condemned, for it is not as a rule from reliance on morphological characters that such naming takes place, but simply from the assumption that the species of fungus which occurs on a certain host-plant in one part of the world will be the same as that growing on the same host in other parts.

The danger of making such assumption is well seen in connection with a mildew common on American roses, which on account of its occurrence on roses has been wrongly referred to the present species. To any one familiar with the appearance of *S. pannosa*

in Europe, with its distinct habit, the remark of Burrill (60, p. 6), that the affinity between *S. pannosa* and *S. humuli* is quite as close as between *S. humuli* and its variety *fuliginea* appears strange, and still more so does Earle's note on the specimen of "*S. pannosa*" in Seymour and Earle's Economic Fungi, no. 131a, that "this form is so like *S. humuli* (DC.) Burrill that it causes doubt in my mind as to whether the two can be kept distinct." On examining American material it became at once clear that what has passed in the United States for *S. pannosa* is for the most part a quite distinct species, viz, *S. humuli*. This form of *S. humuli* on rose-leaves is a very interesting one, and when, as is frequently the case, the appendages are colorless and shining, is identical with "*S. pruinosa*" on *Rhus*. At other times however, the appendages are more or less colored, and there seems little doubt that Earle's opinion that the form is not distinct from *S. humuli* is correct.

It is a most interesting fact that in America *S. humuli* should have attacked roses, while in Europe, where *S. humuli* is equally common, only *S. pannosa* is known on this host. The case, however, is quite analogous with that of another species of the *Erysiphaceae*, viz, *Microsphaera alni* which is very common in the United States on *Syringa vulgaris*, yet in Europe, where both the fungus and the host-plant occur frequently, there is no record of the lilac being attacked by *M. alni*.

I have seen only two specimens of true *S. pannosa* from America —one in Seymour and Earle's Economic Fungi, no. 131b, on *Rosa* sp. from Tennessee ; the other sent to me by Professor G. P. Clinton "on *Rosa* sp. ; stems ; Illinois." Owing to the confusion that has existed between *S. humuli* and *S. pannosa*, mentioned above, it is impossible at present to give the distribution of the latter species in America.

S. pannosa is the "rose-mildew," so well known to rose-growers, and if unchecked is a dangerous disease, quickly spreading from bush to bush in its conidial (*Oidium*) stage. As in the case of the vine-mildew, however, a fungicide which is usually efficacious is found in flowers of sulphur, or potassium sulphide (half an ounce of sulphide of potassium dissolved in a gallon of water). For roses grown under glass, Maynard (243) reports that a sure

and safe remedy is found in the use of evaporated sulphur. The author gives these directions: "In the use of this remedy a small kerosene stove with a thin iron kettle was used, and the sulphur kept boiling two or three hours thrice each week, when the house was kept closed. Care must be taken that only enough heat is used to boil the sulphur, and that it is not set on fire." Guercio and Baroni (101*) recommend as a fungicide the following mixture: carbonate or crystals of commercial soda, kg. 1.5, Norwegian vegetable tar, kg. 0.5; water, liters 100. The soda and tar must be boiled together in about two liters of water, and the rest of the water then added at the ordinary temperature. Spraying with this mixture is stated to have been completely successful in checking the disease in cases where the use of sulphur and sulphate of copper had little effect.

The records of "*S. pannosa*" on gooseberry in America belong to *S. mors-uvae*; those on *Rubus*, and probably also on raspberries, to *S. humuli*. The record of *S. pannosa* on *Spiraea Ulmaria* (391) probably refers to *S. humuli*. Worthington G. Smith (330) states that *S. pannosa* "sometimes grows on *Spiraea* and the hop, but hop-mildew is of course a different fungus." Here again, notwithstanding the concluding remark, *S. humuli* has probably been confounded with the present species.

3. S. MORS-UVAE (Schwein.) Berk. and Curt.

Erysiphe mors-uvae Schwein. Syn. Fung. Am. Bor. 270. 1834.

Sphaerotheca mors-uvae (Schwein.) Berk. and Curt. Grevillea, **4**: 158. 1876; Sacc. Syll. Fung. **1**: 5. 1882; Burr. and Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 399. 1887; Burr.; Ell. and Everh. N. Amer. Pyren., 7. 1892.

Albigo mors-uvae (Schwein.) Kuntze, Revis. Gen. Plant. $\mathbf{3}^2$: 442. 1892.

EXSICC.: Rab.-Wint. Fung. Eur. 3239; Ell. and Everh. N. Amer. Fung. 1536; Roumeg. Fung. Gall. Exsicc. 3882.

Amphigenous; mycelium persistent, when mature forming dense pannose patches, composed of sparingly branched, more or less flexuous, brown hyphae, which are about 5 μ wide, at first pale brown and plainly septate, becoming dark brown and thick-

walled so that the septa and lumen become obliterated; perithecia gregarious, more or less immersed in the persistent mycelium, sub-globose or sometimes slightly irregular in shape, 76–110 μ in diameter, cells large, at first well-defined, then becoming obscure, variable in size, 10–25 μ wide, usually 15–20 μ; appendages usually few (or even obsolete), pale brown, short, and tortuous, rarely more numerous, and longer, up to 5 times the diameter of the perithecium; ascus elliptic-oblong to sub-globose, 70–92, rarely 92–110 × 50–62 μ; spores 20–25 × 12–15 μ.

Hosts.—On the berries, and occasionally stems and leaves of wild and cultivated species of *Ribes; R. cereum* (6), *R. Cynosbati, R. divaricatum*, var. *irriguum, R. floridanum, R. gracile* (—), *R. Grossularia, R. Hudsonianum, R. lacustre, R. Missouriense, R. prostratum, R. rotundifolium, R. rubrum.*

Distribution.—NORTH AMERICA: United States—Maine (163), New York, Pennsylvania! New Jersey (53), Ohio! Michigan, Illinois! Mississippi (361), Wisconsin (97), Missouri! Iowa! Dakota! Nebraska! Montana! Wyoming! Colorado (157) (170).

Botrytis euphorbiae Cast. Supp. Cat. Pl. Mars. 81. 1851.

Erysiphe (*Sphaerotheca*) *tomentosa* Otth, Mitth. natur. Gesell. Bern. 1865: 168. 1866.

Sphaerotheca tomentosa Otth; Jacz. Bull. l'Herb. Boiss. **4**: 723. 1896; Sacc. Hedwigia, **35**: Repert. XXIII. (1896); Dom. Sacc. Att. Soc. Ven.-Treub. Sci. nat., (17) *pl. 5. f. 1.* 1896; Sacc. Syll. Fung. **14**: 462. 1899.

Erysiphe gigantasca Sorok. & Thuem; de Thuem. Myc. univ. no. 645. 1877; Sacc. Syll. Fung. **1**: 18. 1882.

Sphaerotheca gigantasca (Sorok. & Thuem.) Bäuml. in Rehm, Ascom. fasc. XXI. n. 1049. 1891; Hedwigia, **30**: 261. 1891; Schroet.; Cohn's Krypt. Fl. Schles. **3**: 232. 1893.

Albigo tomentosa (Otth) Kuntze, Revis. Gen. Plant. 3^2: 442. 1892.

EXSICC.: de Thuem. Myc. univ. 645*; Syd. Myc. March. 3462 (sub *S. Castagnei*).

Hosts.—*Euphorbia dulcis, E. helioscopia, E. palustris* (20*), *E. Peplus, E. platyphyllos, E. stricta, E. virgata* (164*).

Distribution.—EUROPE: France, Switzerland, Germany, Austria-Hungary, Denmark, Russia.

S. mors-uvae is distinct from *S. pannosa* (with which it has

been occasionally confused in America) in the dark-brown color of the persistent mycelium, the usually smaller ascus, etc.

In 1865 Otth (262) described a species of *Sphaerotheca* on the leaves and stems of *Euphorbia dulcis* in Switzerland, under the name of "*Erysiphe* (*Sphaerotheca*) *tomentosa*," with the following description; "Epiphylla caulinaque. Subiculum maculaeformi-effusum, tomentosum, rufum, in ambitu albidum, e floccis longissimis, rufis, eseptatis, contextum. Conceptacula subiculo inspersa, subimmersa vel plus minus emersa. Appendiculae a subiculi floccis minime distinctae. Sporangium unicum, sporis octonis foetum." In 1877 the same plant was published as a new species under the name of *Erysiphe gigantasca* by Sorokin and de Thuemen (in de Thuemen's Myc. Univ., no. 654) on the stems of *Euphorbia platyphyllos* and *E. dulcis* in Russia. In 1881 Bäumler (20*) recognizing that Sorokin and Thuemen's plant was a *Sphaerotheca*, called it *S. gigantasca*. Jaczewski in 1896 revived the forgotten name of Otth's *S. tomentosa*.

An earlier name, however, for this plant on *Euphorbia* is that of *Botrytris euphorbiae*, published by Castagne (67) in 1851 for a fungus on *Euphorbia Peplus*. The identity is pointed out by M. Hariot in a note attached to a specimen of "*Botrytris euphorbiae* Cast" in the herbarium of the Paris museum, in which it is stated that in this author's opinion the fungus is "*Erysiphe gigantasca* Sorok. & Thuem." The specimen is very young, and the mycelium has not yet attained its characteristic brown color, but I was able to find a few perithecia, showing a single ascus, and there can be no doubt that the *Botrytis euphorbiae* of Castagne is the same fungus as Otth's *Sphaerotheca tomentosa*.

Although the specific validity of this European fungus on *Euphorbia* has not hitherto been questioned, it appears to me that it cannot be separated from *S. mors-uvae*. After much comparison I have failed to find sufficient characters to separate this European plant on *Euphorbia* from the American one on *Ribes*. Although as a rule the fungus on *Euphorbia* affects the stems rather than the leaves, there are specimens in Otth's herbarium, noted as "forma epiphylla," in which it forms irregular pannose or felted patches on the leaves, exactly resembling those of *S. mors-uvae* on the fruit of American gooseberries. The dark brown hyphae of the

persistent mycelium in the two forms (on *Euphorbia* and *Ribes*) are morphologically the same ; the only difference I have been able to detect is that in the form on *Euphorbia* the hyphae are perhaps slightly more flexuous, and the perithecia are sometimes more irregularly shaped, with a slightly larger (especially longer) ascus ; but these differences are not, I believe, constant, and at any rate are not more marked than those often found in the forms of one species on different host plants. On the other hand there is so close a resemblance in the habit and general morphological characters of the two forms that I feel compelled to consider them as belonging to one species. It would be extremely interesting if experimental work could be carried out to test the correctness of this view that the fungus on American gooseberries and on European spurges belongs to the same species. The plant on *Euphorbia* is apparently not common in Europe, but where it does occur it should be seen if the conidia are capable of infecting gooseberries ; in America attempts should be made to infect species of *Euphorbia* with the conidia of *S. mors-uvae* on *Ribes*.

I have, in two instances, seen perithecia containing three asci in American specimens of *S. mors-uvae* ; the asci were much smaller than usual (about $60 \times 35\ \mu$) and ovate-oblong in shape.

The record by Berkeley (35) of the occurrence of the present species on "grapes" is due to some error, as in the specimen (now in the Kew Herbarium) to which reference is made, the fungus is growing on the leaves and the berry of some species of *Ribes*.

In America *S. mors-uvae* is common on wild and cultivated species of *Ribes*, and is well known as a widely-spread disease under the name of the "gooseberry-mildew." As the specific name denotes, the fungus is especially harmful in attacking and destroying the fruit, covering the berries with its persistent felted dark-brown mycelium. It is not, however, confined to the fruit, but often forms large confluent patches on the stems and leaves.

As a fungicide, Goff (147) recommends potassium sulphide. The mixture used was one-half or one-fourth of an ounce of the sulphide to a gallon of water, and was applied "as soon as the leaves had begun to expand (May 3), and the application was repeated after every hard rain until June 24, nine sprayings having been made in all. The new growth, as well as the crop of fruit,

was very perceptibly greater on the treated plants." In a series of experiments, on a large scale, carried on by Close (72) the same fungicide was found the most effective. The potassium sulphide solution here used was of the strength of one oz. to two gallons of water. Spraying should be begun very early, just as the buds are breaking, and continued at intervals of about ten days. It was found that English varieties and their seedlings were, as a rule, more subject to attack than the American varieties.

The gooseberry disease caused by *S. mors-uvae* is confined to North America; the disease, called in Europe the "gooseberry mildew," is due to the attacks of *Microsphaera grossulariae* and is not so dangerous, as it attacks only the leaves of gooseberry bushes.

4. S. lanestris Harkn.

S. lanestris Harkn. Bull. Calif. Acad. Sci. **1**: 40. 1886; Sacc. Syll. Fung. Addit. ad Vols. I–IV: 1. 1886; and **9**: 364. 1891; Burr.; Ell. and Everh. N. Amer. Pyren. 9. 1892.

Albigo lanestris (Harkn.) O. K. Revis. Gen. Plant. 3^2: 442. 1892.

Exsicc.: Ell. and Everh. N. Amer. Fung. sec. ser. 1537; Rab.-Wint. Fung. Eur. 3240; * Seym. and Earle, Econ. Fung. 188.

Hypophyllous; mycelium persistent, when mature more or less covering the under surface of the leaf, and composed of a compact rather dense mass of much-branched, very tortuous, interwoven, brown hyphae, which are thick-walled, or more or less solid through the obliteration of the lumen; perithecia gregarious, imbedded in the persistent mycelium, subglobose, 80–120 μ in diameter, cells of outer wall obscure, irregularly shaped, 10–20 μ wide, inner wall becoming completely free from the outer, formed of sub-hexagonal colorless cells with refractive walls, about 15 μ wide; appendages very short or obsolete, often entirely absent; ascus large, from elliptic- to broadly-oblong, more or less distinctly stalked, 100–130 × 60–75 μ; spores 8, 24–30 × 18–20 μ.

Hosts.—*Quercus agrifolia*, *Q. alba* (12) (361), *Q. macrocarpa*, *Q. minor* (361), *Q. Prinus*, *Q. rubra* (361).

Distribution.—North America: United States—Alabama, Illinois! Mississippi (361), Missouri! Iowa (361), California!

"Very conspicuous upon the growing shoots of *Quercus agrifolia*—the *Oidium* as a white mealy stratum from Feb.–May, followed by the ascophore on the leaves below. San Francisco" (Harkness, l. c.).

S. lanestris is a very conspicuous fungus in its dense scattered or confluent patches, of a dull, dark-brown color when mature, on the under side of oak leaves. In general habit it approaches, through its persistent brown mycelium, *S. mors-uvae*, from which it is, however, quite distinct in the more closely interwoven hyphae, which are much more tortuous or even angularly bent, the separating inner wall of the perithecium and the larger, usually slightly stalked ascus.

The inner wall of the perithecium is formed of colorless angular cells, about 15 μ wide, with refractive walls, and, as the perithecium approaches maturity, becomes completely separated from the outer wall. When a nearly ripe perithecium is pressed open, the ascus is forced out enveloped in the still unbroken inner wall. Even with a perfectly ripe perithecium, when the free ascus escapes, the inner wall on gentle pressure usually follows the ascus in the shape of a hollow globular body split towards the apex. In this character *S. lanestris* recalls *S. phytoptophila* (see fig. 124).

Burrill (60) says, "The perithecia * * * when carefully separated appear to be absolutely without appendages." Although this is frequently the case, I have occasionally seen a few very short, pale brown appendages at the base of the perithecium, usually very much shorter than, and never exceeding, its diameter.

Harkness (158) described the *Oidium* form of *S. lanestris* as follows "*O. ventricosum;* segments swelling in the center and becoming barrel-shaped, 34–38 × 20–22 μ, and filled with numerous round or elliptic bodies, 5–6 × 2–4 μ, which are freely discharged from the ends, as the joints separate." It seems probable that what was seen was merely the granular protoplasm escaping from injured conidia.

Tracy and Galloway (363) remark of *S. lanestris*, "the dense mycelium completely covers the young leaves and twigs, causing the former to shrivel and cease growing before they attain one-fourth their usual size."

5. S. PHYTOPTOPHILA Kellerm. & Swingle. [Figs. 124–126]

S. phytoptophila Kellerm. & Swingle, Journ. Myc. **4**: 93. 1888; Kellerm. & Swingle, Ann. Rep. Kansas Exper. Sta. **1**: 310. *pl. 4. f. 7–13.* 1889; Sacc. Syll. Fung. **9**: 365. 1891; Burr.; Ell. Everh. N. Amer. Pyren. 9. 1892.

Albigo phytoptophila (Kellerm. & Swingle) Kuntze, Revis. Gen. Plant. 3^2: 442. 1892.

EXSICC.: Kellerm. & Swingle, Kans. Fung. 23; Ell. & Everh. N. Amer. Fung. sec. ser. 2336; Rab.-Wint.-Pazsch. Fung. Eur. 3954; *Seym. & Earle, Econ. Fung. 148.

Mycelium evanescent, or subpersistent; perithecia more or less gregarious, 60–78 μ in diameter, cells small, about 10 μ wide, often indistinguishable, inner wall colorless or pale yellow (cells 10–15 μ wide, with refractive walls), usually separating entirely from the outer wall; appendages usually short, sometimes obsolete, more or less tortuous, pale or dark brown, sometimes as long as 4 times the diameter of the perithecium, septate, occasionally branched; ascus elliptic-oblong to globose, and 60–75 × 42–50 μ; spores 8.20–25 × 12–15 μ.

Host.—*Celtis occidentalis*, on distortions caused by a species of *Phytoptus* (gall-mite).

Distribution.—NORTH AMERICA: United States—Ohio, Indiana, Illinois (60), Missouri, Iowa, Kansas.

Kellerman and Swingle (197) give the following description of the present species: "Mycelium very sparse; perithecia globular, dark brown or black, obscurely reticulate, 60–80 micr., mostly 65–75 micr. in diam., appendages few, more or less evanescent, dark brown, irregular but usually about 6 micr. in diam., and mostly longer than the diam. of the perithecia, often septate. Asci large, hyaline, broadly oval, containing 8 spores, which are hyaline, oval, regular in size, 15 × 24–18 micr. Conidial stage: mycelium more abundant, conidiophores hyaline, erect, total height (including conidia) 150–220 micr. by 9–13 micr. in diam., conidia oval, hyaline, continuous, granular within, 15 × 21–29, mostly 15 × 27 micr.

"The fungus is found associated with *Phytoptus* (an undescribed species) on Hackberry (*Celtis*). The distortions caused by the insect, or perhaps by both insect and fungus, consist of a multitude of abnormal, more or less abortive branchlets that form a compact knot, ½–1½ inches in diam.; a few of the branchlets are prolonged a few inches and themselves bear smaller

knots of similar structure. The abortive branchlets have excessively numerous buds all infected by the insect, and covered by the fungus. The conidial stage is found associated with the perithecia and sometimes even extending out on the twigs to the under side of the leaves. The perithecia are found in the spring but do not mature their spores till late fall or winter."

The more obscure cells of the outer wall of the perithecium, the tendency of the inner wall to separate completely from the outer, and the smaller average size of the perithecium and ascus seem to be the only characters separating the present plant from *S. humuli*, and are hardly important enough, by themselves, to give specific rank. There is some evidence, however, which points to the possibility of *S. phytoptophila* being distinct as a "biological" species, and it is from these considerations, viz: that it is possible that the present plant is a species closely allied morphologically to *S. humuli*, but yet physiologically so dependent on its special host as to be unable to grow elsewhere, that I have kept the two distinct.

In the specimens I have seen of *S. phytoptophila* the inner wall of the perithecium, composed of colorless, angular (often hexagonal) cells with refractive walls, shows a marked tendency to separate completely from the outer wall. When a ripe perithecium is burst by pressure, causing the expulsion of the ascus, the inner wall, often in the form of a hollow oval body split at one side, is forced out at the same time (see Fig. 124). If the perithecium which is opened is immature, the inner wall is frequently pressed out unburst, completely enclosing the ascus. In *S. humuli* the inner wall very rarely, if ever, presents this appearance, usually closely adhering in fragments to the outer wall, or becoming more or less absorbed. The small size of the ascus and perithecium could probably be matched in certain forms of *S. humuli*.

The following observations of Halsted's (155) made on living examples of *S. phytoptophila* are of great interest: "At this season of the year (January) all traces of the mildew are absent from anything except the infested or abnormal branches, and upon these the perithecia are limited to the bud-scales, with a particular preference shown to the lower portion of the scale. Upon further study, the buds infested were found to be much

larger than those upon healthy branches and contained the perithecia in all their tissues. For example, a bud well up from the base of a twig might not show any signs of perithecia upon the exterior, but when the large loose scales were removed the bases of the inner ones would expose a dark covering consisting of the mildew perithecia. Longitudinal sections through such buds showed that the living tissue of an ordinary bud was absent, and its space was occupied by an entangled mass of fungous fruit. . . . As fungus parasites thrive upon compounds rich in albuminous substances, and as the *Phytoptus* induces a rapid and, therefore, comparatively succulent growth upon a tree that normally has a dense wood, firm bark, and minute, closely protected buds, it may, however, not be so strange that the *Sphaerotheca* will flourish upon the distortions caused by the mite when it fails to gain a foothold upon a healthy twig. . . . It was, moreover, observed that in a cross-section of the stimulated branch there was considerable starch scattered through the bark, while in the healthy and mature twigs, where the buds were normal, smooth-coated, and varnished, there was no starch outside the ring of firm wood. This starch in the bark may be the secret of the success of the *Sphaerotheca* upon the infested branches."

It is this apparently intimate association of *S. phytoptophila* with the galls of the *Celtis* that suggests the idea of the plant being biologically distinct, and experiments bearing on this point, either the sowing of the conidia of *S. phytoptophila* on host-plants of *S. humuli* or, conversely, attempts to infect the galls of the *Celtis* with the conidia of *S. humuli* are very desirable.

Kellerman and Swingle (198) mention that they were unable to find any haustoria in living specimens, but consider that this may have been due to the distorted nature of the epidermal cells.

Other cases of the occurrence of species of the *Erysiphaceae* on galls caused by mites are known. The form of *Microsphaera alni* described as "*M. erineophila*" occurs on "erineum" galls on leaves of *Fagus ferruginea; M. alni* also occurs under the same conditions on leaves of *Cephalanthus occidentalis*. In both these cases, the presence of the galls seems to cause the appendages of the fungus to become colored, but there is no reason for considering the form a distinct species,

nor to suppose that any intimate connection exists between the fungus and the mite. I have once seen *Uncinula circinata* on "erineum" galls on the leaves of *Acer rubrum*, and in this instance the unusual habitat had no observable effect on the fungus. Halstead (156) records the occurrence of "*Sphaerotheca pruinosa*" on *Phytoptus* distortions on the inflorescence of *Rhus glabra*. All these cases, however, differ from that of *S. phytoptophila* in one important respect, viz., that the species of fungi recorded are found commonly on the same host-plant when this is not attacked by mites, while *S. phytoptophila* (or any species of *Sphaerotheca*) has not been recorded from *Celtis* unless this host-plant has been altered by the attacks of the *Phytoptus*.

Anderson and Kelsey (7) mention an association with mites of "*S. Castagnei*" on *Shepherdia argentea*, and of *S. mors-uvae* on *Ribes rotundifolium*, stating that "in both cases the distorted leaf-axils, abnormally developed buds, and thickened brittle upper leaves bore the perithecia of largest size and in greatest numbers." Instances are also given of mites occurring with "*S. Castagnei*" on *Geranium incisum*, with *Erysiphe communis* on *Oxytropis Lamberti*, *Astragalus triphyllus*, and *A. adsurgens*, and with *E. cichoracearum* on *Chrysopsis villosa*, *Helianthus* (several species), *Cnicus undulatus*, *Erigeron macranthus* and *Mertensia Sibirica*. In all these cases, however, we may note that the fungus in question occurs commonly on unattached parts of the host-plant mentioned, and in many cases it is very probable that the presence of the mites is merely a coincidence.

UNCINULA Lév. Ann. Sci. Nat. III. **15**: 151. 1851

Perithecia globose to globose-depressed; asci several, 2–8 spored; appendages simple, or rarely (*U. aceris*) once or twice dichotomously forked, uncinate at the apex, usually colorless, rarely dark brown at base or throughout. Etym.: dim. of *uncus*.

Distribution.—Europe, Africa, Asia, Australia, North and South America—18 species and 2 varieties.

The genus is distinguished at once by the uncinate apex of the appendages.

Key to the Species of the Genus Uncinula

1. Appendages colored. 2.
   Appendages colorless. 3.

2. Appendages colored for half their length or more. 5. *necator.*
Appendages colored only at base (up to the first septum). 16. *australiana.*
3. Asci 2–3-spored. 4.
Asci 4–8-spored. 6.
4. Asci more than 30, perithecia very large, 215–320 μ in diameter. 12. *polychaeta.*
Asci 4–20, perithecia 85–165 μ in diameter. 5.
5. Appendages 9–25, perithecia average 95 μ in diameter, asci 3–6. 4. *clandestina.*
Appendages 50–130, perithecia average 130 μ, asci 8–20. 8. *macrospora.*
6. Appendages all simple. 7.
Appendages some or all branched. 20.
7. Appendages delicate, narrow, 3–4 μ wide, asci 4–7-spored. 8.
Appendages stouter, wider, or if narrow with asci 8-spored. 10.
8. Asci about 25, perithecia 150–200 μ in diameter. 13. *confusa.*
Asci 5–8, perithecia 86–122 μ in diameter. 9.
9. Appendages 50–160, ½–¾ diameter of perithecium. 7. *parvula.*
Appendages 24–46, 1¼–2 diameter of perithecium, often geniculate. 11. *geniculata.*
10. Appendages stout, 7–8 μ wide near the base. 11.
Appendages narrower near the base. 12.
11. Appendages very few, 6–12, enlarged upwards. 15. *Delavayi.*
Appendages crowded, 20–36, scarcely or not at all enlarged upwards. 18. *Sengokui.*
12. Appendages abruptly flexuose or angularly bent. 13.
Appendages straight. 14.
13. Appendages about equalling diameter of perithecium, flexuose above, not angularly bent, spores usually 8. 9. *flexuosa.*
Appendages 1–2, usually 1½–2 diameter of perithecium, more or less angularly bent, spores 4–6, rarely 7. 1. *salicis*, var. *Miyabei.*
14. Appendages thick-walled, refractive, or rough at base. 15
Appendages thin-walled throughout. 17.
15. Mycelium persistent, densely compacted, perithecia 156–268 μ in diameter. 2. *aceris*, var. *Tulasnei.*
Mycelium evanescent or subpersistent, perithecia 64–146 μ in diameter. 16.
16. Asci ovate or elliptic-oblong, 24–30 μ wide, spores 16–20 × 8–10 μ. 3. *prunastri.*
Asci broadly ovate to subglobose, 34–40 μ wide, spores 20–25 × 10–13 μ. 10. *Clintonii.*
17. Asci 4–6-spored. 1. *salicis.*
Asci 7–8-spored. 18.
18. Perithecia 168–224 μ in diameter, appendages not exceeding diameter of perithecium. 6. *circinata.*
Perithecia 76–138 μ in diameter, appendages 1¼–2½ times diameter of perithecium. 19.
19. Perithecia 120–138 μ in diameter, appendages 35–60, mycelium persistent, more or less densely compacted. 14. *australis.*
Perithecia 76–105 μ in diameter, appendages 10–28, mycelium evanescent. 17. *fraxini.*
20. Mycelium densely compacted, appendages mostly simple. 2. *aceris*, var. *Tulasnei.*
Mycelium not densely compacted, appendages all or nearly all branched. 2. *aceris.*

1. UNCINULA SALICIS (DC.) Winter. [Figs. 62, 63, 85]

Erysiphe salicis DC. Fl. Fr. **2** : 273. 1805 ; Duby, Bot. Gall. **2** : 871. 1830 ; Tul. Sel. Fung. Carp. **1** : 198. *pl. 2. f. 1.* 1861.

E. populi DC. Syn. Pl. Fl. Gall. 57. 1806 ; de Bary, Beitr. Morph. Phys. Pilz. **1** : § xiii., 52. 1870.

E. varium Fr. Obs. Myc. (partim) **1** : 206. 1815, and **2** : 366. 1818.

Alphitomorpha adunca, var. *populi* Wallr. Berl. Ges. Nat. Freund. Verh. **1** : 37. 1819.

A. populi Wallr. Ann. Wett. Ges. **4** : 236. 1819.

A. obtusata Schlecht. Berl. Ges. Nat. Freund. Verh. **1** : 50. 1819.

Erysibe populi DC. Gray Nat. Arr. Brit. Pl. **1** : 589. 1821.

E. adunca var. *populi* Lk. ; Willd. Sp. Pl. **6** : 111. 1824.

E. obtusata (*salicis*) Lk. ; Willd. Sp. Pl. **6** : 117. *pl. 1.* 1824.

E. adunca Schlecht. Fl. Berol. **2** : 169. 1824.

Erysiphe adunca Lk. ; Grev. Scot. Crypt. Fl. **5** : *pl. 296.* 1827 ; and **6** : (Synops.) 9. 1828 ; Berk. ; Sm. Engl. Fl. **5** : *pl. 2.* 327. 1836.

E. adunca, vars. *populi* et *salicis* Fr. Syst. Myc. **3** : 245. 1829.

E. adunca, var. *populi* Duby, Bot. Gall. **2** : 870. 1830.

E. capreae (DC. Herb.) ex Duby, Bot. Gall. **2** : 871. 1830.

Alphitomorpha adunca, var. *amentacearum* Wallr. Fl. Crypt. Germ. **2** : 755. 1833.

Erysibe adunca var. *amentacearum* Rabenh. Deutschl. Krypt. Fl. **1** : 235. 1844.

Uncinula adunca Lév. Ann. Sci. Nat. III. **15** : 151. *pl. 7. f. 15.** 1851 ; Cooke, Micr. Fung. **219** : *pl. 11. f. 221–224.* 1865 ; Cooke, Handb. Brit. Fung. **2** : 646. *f. 314.* 1871 ; Peck, Trans. Alb. Inst. **7** : 214. *f. 1–3.* 1872 ; Karst. Myc. Fenn., **2** : 196. 1873 ; Sacc. Syll. Fung. **1** : 7. 1882.

U. luculenta E. C. Howe, Journ. of Bot., II. **1** : 170. 1872.

U. heliciformis E. C. Howe, Bull. Torr. Club, **5** : 4. 1874 ; Sacc. Syll. Fung. **9** : 367. 1891.

U. salicis (DC.) Wint. ; Rabenh. Krypt. Fl. Deutschl. **1**^{2} : 40.

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* Excl. syn. *Alphitomorpha depressa*, var. *artemisiae* Wallr. and *Erysibe depressa*, var. *artemisiae* Lk.

1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 94. 1885; Burr. and Earle, Bull. Ill. St. Lab. Nat. Hist. **2**: 410. 1887; Burr.; Ell. and Everh. N. Amer. Pyren. 19. *pl. 2.* 1892; Schroet.; Cohn's Crypt. Fl. Schles. **3**: 245. 1893; Jacz. Bull. l'Herb. Boiss. **4**: 742 (syn. excl. partim). 1896; Oudem. Rév. Champ. Pays-Bas. 87. 1897.

Erysiphe populi Patouill. Journ. de Bot. **2**: 217 (cum icon.). 1888; Sacc. Syll. Fung. **9**: 370. 1891.

Uncinula Columbiana Selby, Bull. Ohio Agric. Exper. Sta. (Techn. Ser.) **1**: 221. *pl. 3. f. 5.* 1893; Sacc. Syll. Fung. **11**: 252. 1895.

U. salicis, var. *epilobii* Vestergr. Botan. Notiser, 256. 1897; Sacc. Syll. Fung. **14**: 462. 1899.

Exsicc.: Bri. e Cav. Fung. par. 69, 171; Fckl. Fung. Rhen. 699, *700, 2236; Cooke, Fung. Brit. Exsicc. *447, ed. 2, 597; de Thüm. Fung. Austr. 130, 131, 132, 236, 655; de Thüm. Myc. univ. 959; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 268, 2195, *ed. 2, ser. 1, 113, 1845; Rehm, Ascom. 549, 550; Rab. Fung. Eur. 560, 1045, 2316, 2317; Rab. Herb. Myc. ed. 2, 464, 465; Rab.-Wint. Fung. Eur. 3046; Baxt. Stirp. Crypt. Oxon. fasc. 2, 29; Karst. Fung. Fenn. 367; Sacc. Myc. Ven. 615, 890; Ellis, N. Amer. Fung. 425; Roumeg. Fung. gall. exsicc. 970; Syd. Myc. March. 836, 1657, 2329; Jack, Lein. and Stizenb. Krypt. Bad. 630; Westend. Herb. Crypt. Belg. 80; Ellis and Everh. Fung. Columb. 109, *314; Ellis and Everh. N. Amer. Fung. 3007; *Wartm. and Schenk, Schweiz. Krypt. 320; *Kneiff. and Hartm. Pl. Crypt. Bad. 17; *Seym. and Earle, Econ. Fung. 198; *Hoppe, Fung. Epiphyt. 5, 6, sub *Sclerotium erysiphe* Pers.; Jacz. Kom. Tranz. Fung. Ross. Exsicc. 28 (in Herb. Hort. Imp. Petrop.); *Erikss. Fung. par. scand. 34; Schleich, Crypt. exsicc. 77 (in Herb. DC.).

Amphigenous; mycelium evanescent, or persistent and then usually thin and effused, but sometimes densely compacted and forming definite circumscribed patches; perithecia densely gregarious or more or less scattered, globose-depressed or lenticular, 90–175 μ in diameter, averaging 135 μ, cells 10–15 μ wide; appendages usually numerous, often densely crowded and 100–150, or more, sometimes fewer, rarely only 30–15, ¾–2½ times the diameter of the perithecium, simple, aseptate, or occasionally 1-

septate at the base, hyaline and thin-walled throughout, usually gradually and slightly enlarged upwards, apex simply uncinate or occasionally more or less helicoid; asci 8–14, rarely only 4–6, elliptic-oblong or broadly ovate, usually stalked, 55–80 × 30–40 μ, averaging 68 × 36 μ; spores 4–6, 20–26 × 10–15 μ.

Hosts.—*Populus alba*, *P. angustifolia* (6), *P. balsamifera* and var. *candicans*, *P. ciliata*, *P. grandidentata*, *P. heterophylla*, *P. monilifera*, *P. nigra*, *P. pyramidalis*, *P. tremula*, *P. tremuloides*, *P. trichocarpa*, *Salix alba*, *S. angustifolia* (57), *S. aurita*, *S. Capraea* and var. *pendula*, *S. cinerea*, *S. cordata*, *S. daphnoides*, *S. discolor*, *S. flavescens* and var. *Scouleriana*, *S. fragilis* (22) (344), *S. glauca* (6), *S. humilis*, *S. incana* (230), *S. livida*, *S. longifolia* (6), *S. nigra* and var. *falcata*, *S. nigricans*, *S. petiolaris*, *S. purpurea*, *S. pyrolaefolia* (347), *S. repens*, *S. sericea*, *S. Seringiana*, *S. triandra*, *S. Urbaniana*, *S. viminalis* [*Betula alba* (107) (176) (204) (214) (307) (394), *Buxus sempervirens* (383)].

Distribution.—EUROPE: Britain, France, Portugal, Belgium, Netherlands (263), Germany, Switzerland, Italy, Austria-Hungary, Denmark, Norway, Sweden, Finland, Russia.

ASIA: Transcaucasia (338), Siberia (Minussinsk), India, China (Yunnan), Japan.

NORTH AMERICA: United States—Maine, Vermont, Massachusetts, New York, New Jersey (53), Carolina (90), Ohio, Michigan, Indiana, Illinois, Mississippi (361), Wisconsin, Missouri, Iowa, Minnesota, Kansas, Dakota, Montana, Wyoming, Washington, California. Canada—Ontario, Quebec.

The most widely distributed and the most variable species of the genus, but, as a rule, easily recognized by the numerous simple appendages slightly exceeding the diameter of the perithecium. The appendages are usually slightly enlarged upwards (but not sufficiently so as to make the apex club-shaped) and remain hyaline and thin-walled throughout, not becoming thick-walled or refractive towards the base, as is the case with several allied species.

Although there can be no doubt that the two forms growing respectively on poplars and willows constitute but a single species, we usually find these two forms characterized as follows. The form of *U. salicis* occurring on species of *Salix* has uniformly larger peri-

thecia, the appendages in proportion to the diameter of the perithecium are shorter, nearly always more or less crowded, and have a small and closely uncinate apex ; the asci are usually 4-spored. In the form of *U. salicis* occurring on species of *Populus* the perithecia average smaller, the appendages are fewer—in rare cases as few as 15—longer, more flaccid, with the apex frequently more loosely uncinate, and the asci are more often 6-spored. So many examples, however, on both *Salix* and *Populus* show characters intermediate in every respect—for instance, it is not at all uncommon to find forms on *Populus* in which the appendages are very crowded—that, as already mentioned, the two forms cannot be considered specifically distinct. We may, however, perhaps regard them as incipient species which are being evolved on different host-plants.

Léveillé (214), Winter (394), Jaczewski (176), Saccardo (307), and other authors have recorded *U. salicis* as growing on *Betula*, but I have not been able to find specimens on this host-plant in any herbarium. It may be that perithecia (without appendages) of *Phyllactinia corylea*—a species which occurs commonly on *Betula*—have been mistaken for immature examples of the present species, and the same suggestion may be made with regard to Wallroth's (383) record on *U. salicis* on *Buxus sempervirens*.

Léveillé (214, p. 151) recorded *Artemisia vulgaris* as a host-plant for *U. salicis*, and (l.c., p. 152) gave "*Alphitomorpha depressa* var. *β artemisiae* Wallr." as a synonym of the present species. Léveillé remarked, "J'ai reçu beaucoup d'échantillons d'Erysiphés sur l'Armoise sous le nom d' *Erysiphe depressa*, et pas un ne se rapporte avec celui de Wallroth, que renferme l'herbier de M. DeCandolle. C'est cette espèce que je réunis à l' *Uncinula adunca* [*U. salicis*], parce qu'elle en présente tous les caractères ; l'autre est un Erysiphé proprement dit." In Berkeley's herbarium, at Kew, there is a specimen from Léveillé's herbarium, labelled in the latter author's handwriting "*Uncinula adunca. Alphitomorpha depressa* Wallr. *β. artemisiae.* Specim. Wallrothii."

On this specimen (on the leaf of *Artemisia vulgaris*) there are two species, viz : *Uncinula salicis* and *Erysiphe cichoriacearum.* Of the former species, I found only two perithecia. These were quite loose and merely entangled in the hairs of the leaf, and I feel no hesitation in regarding their presence as accidental. Wallroth's

Alphitomorpha depressa, var. *artemisiae* is certainly *Erysiphe cichoracearum*, as an examination of Wallroth's type shows. Other authors also (107) (204) have stated that *Uncinula salicis* occurs on *Artemisia*, but it is very probable that the statement is often copied from Léveillé. Pâque (270) has lately (1885) recorded *U. salicis* on this host, but the specimens kindly sent to me by this author prove to be *Erysiphe cichoriacearum*.

The record by Cooke and Peck (91, p. 170) of the occurrence of the present species on *Aesculus* is a mistake, and refers to *Uncinula flexuosa*.

Uncinula luculenta E. C. Howe is one of the forms of *U. salicis* on poplar, and has been correctly referred to this species by American botanists.

U. heliciformis E. C. Howe (on *Populus balsamifera* in the United States) cannot be separated from *U. salicis*, although it is in certain respects a marked form. Howe (167) described the appendages as "spirally coiled above, colored at base," and on a specimen (now in the Kew Herbarium) sent to Cooke, has remarked, "possibly a variety which unites *U. spiralis* B. & C. with *U. ampelopsidis* Peck." An examination of this specimen showed the perithecia to be 80–120 μ in diameter with 24–38 colorless aseptate appendages, about 1½ times the diameter of the perithecium. The apex of the appendages is, when mature, 2–3 times coiled in a helicoid manner (Fig. 85), and in this respect is similar to that of *U. necator* (*U. spiralis*). In all other characters, however, especially in the colorless aseptate appendages "*U. heliciformis*" shows no affinity whatever with this species. It is certain, too, that a more or less helicoid apex to the appendages must be regarded as a character of very little value, as it appears occasionally in species which normally have a simply uncinate apex, *e. g.*, *U. macrospora*, *U. fraxini*, etc. Among some specimens of *U. salicis* sent to me by Professor Massalongo, from Italy, an example occurs on *Populus nigra* in which many, though not all, of the appendages have a distinctly helicoid apex. On the whole, therefore, "*U. heliciformis*" must be ranked as only an interesting form of *U. salicis*.

Erysiphe populi Patouill. on *Populus tremula* from China (Yunnan) is *U. salicis*, and was described from immature peri-

thecia before the appendages had become uncinate (see figure in Journ. de Bot. 2: 217. 1888). M. Patouillard kindly sent me specimens (now in the Kew Herbarium), on which was noted "*Erysiphe* (*Uncinula*) *populi* Pat.; diffère de *U. adunca* [*U. salicis*] par ses thèques sub-6-spores." Examination showed the asci to be 4–6-spored, and in this and all other characters M. Patouillard's plant agrees perfectly with *U. salicis.*

U. Columbiana Selby was published as growing on *Scutellaria lateriflora* at Columbus, Ohio. The author remarked (324), "This species resembles *U. circinata* C. & P. in the form of perithecia, but is distinguished from it by the more abundant mycelium, by the broader asci, and the fewer and larger spores. Unlike previously reported species of the genus its host is a herb and one commonly affected by an *Erysiphe.* The material on hand is mature though rather scanty." Professor Selby very kindly sent me the type specimens for examination. I found the perithecia to measure 100–150 μ in diameter, the appendages are numerous, hyaline and thin-walled throughout, simply uncinate, 1–1½ times the diameter of the perithecium; the asci are about 60 × 35 μ, 5- or 6-spored, spores 20–22 × 10 μ. In all respects, therefore, the specimen agrees well with *U. salicis*; *U. circinata* differs in the larger perithecia, shorter appendages, larger asci, and 7–8 spores. Professor Selby's material shows some perfectly ripe perithecia, but is rather scanty, and I have not been able to satisfy myself perfectly that the *Uncinula* was *growing* on the *Scutellaria.* There is certainly a species of mildew growing on the *Scutellaria* leaves, as is shown by the presence of some young perithecia on the mycelium, but, as far as I have been able to see, these are too young to show any appendages, and it is just possible that they do not belong to the *Uncinula*, but to *Erysiphe cichoracearum*, which is not uncommon in America on this *Scutellaria.* The *Uncinula* has not been reported subsequently on *Scutellaria*, and considering that there is a possibility that its presence on this plant was accidental, it will be wiser to wait for confirmation before recording *Scutellaria lateriflora* as a host plant for *Uncinula salicis.* Perhaps a parallel case to the above is afforded by the occurrence of *U. geniculata* on *Hydrophyllum*, mentioned below or of *U. salicis* on *Artemisia* (see above). By a curious mistake Saccardo gives, in

his Host Index, "*Uncinia Columbiana*" as the host plant of Selby's species.

U. salicis has been hitherto recorded from Asia only from Siberia (Minussinsk). It appears, however, to be not uncommon in Japan, whence Professor Miyabe has sent me specimens on five species of *Salix* and on three species of *Populus;* from China (Yunnan) it has been recorded, as mentioned above, under the name of *Erysiphe populi.* The present species occurs also in India, but has been recorded as *Erysiphe Martii* by Cooke, in Grevillea (83). The specimen, collected at Simla on *Populus ciliata*, is in the Kew Herbarium; it is somewhat immature, but shows some fully ripe and characteristic perithecia.

Oestergren (372) has recently described a fungus from Upsala, under the name of *Uncinula salicis* (DC.) Wint. var. *epilobii* n. v., on which the following interesting observations (here given in translation) are made:

"The host-plants which are given in the literature for *Uncinula salicis* belong to the genera *Salix*, *Populus* and *Betula;* it was, therefore, quite surprising to find the above form, which very closely agrees with *U. salicis*, on a host so widely different from these genera as *Epilobium angustifolium.* *U. salicis* appears, however, to have been once before recorded on a herbaceous plant, as Winter (Die Pilze Deutschl. etc., **2**: 40) remarks that this species "soll auch auf *Artemisia vulgaris* gefunden worden sein, doch erscheint diese Angabe sehr unwahrscheinlich." As mentioned above, the form found on *Epilobium* agrees in its chief characters with *U. salicis.* It appears worthy of note that the appendages which are here so numerous at the base of the perithecium are only of the same length as the perithecium, while in the type on the contrary they attain to quite double this length, and it is worthy of remark, also, that at the time of maturity of the fungus the mycelium appears to have almost completely disappeared, while in the type, on the other hand, it is generally persistent. I have, however, found the same behavior with regard to the mycelium in several examples of *U. salicis* in the botanical collections of the Upsala Museum. As the biological adaptation of the *Erysipheae* to different host-plants is almost unknown, it may be best to denote the morphological agreement of this form with *U. salicis*

by placing it as a variety under this species, although it is, perhaps, not improbable that it is, biologically, distinct from it. The most obvious presumption would be that the perithecia of the *Uncinula* in question had been transferred by the wind to the *Epilobium* from, *e. g.*, some *Salix* bushes growing in the neighborhood. Apart from the fact that there were none of the usual host-plants of *U. salicis* in the neighborhood one must quite reject this presumption when one observes (under a slight microscopic magnification) how firmly the perithecia of the var. *epilobii* are fixed to the substratum by means of the appendages radiating on all sides. Moreover, the infected shoots were densely covered along their entire length with perithecia, whereas no signs of the fungus could be found on herbaceous plants growing in the neighborhood."

I have not seen a specimen of this *Uncinula* on *Epilobium*, but from the diagnosis and the author's remarks there seems no reason whatever for separating it from *U. salicis*. Certainly the characters chiefly relied upon, viz, the length of the appendages and the evanescence of the mycelium, cannot be considered distinctive of the "var. *epilobii*" (cf. the diagnosis of *U. salicis* given at p. 82). The question whether any form on a certain host-plant is biologically distinct can only be answered by experiment, for its mere assumption would lead to the establishment of a new "biological" variety or species at each occurrence of a species on a new host-plant. Also, remembering the case of the accidental occurrence of *U. salicis* on *Artemisia* (and perhaps also on *Scutellaria*) mentioned above, it will be best to wait until perithecia have been seen growing on a mycelium on the *Epilobium* before recording the latter as a host-plant for *U. salicis*, although in the present case the crowded habit of the perithecia makes it seem probable that the *Epilobium* was serving as a host-plant.

The fungus described as parasitic on perithecia of *Uncinula salicis* by Cocconi (75*), under the name of *Phoma uncinulae*, is probably *Ampelomyces*.

Var. **Miyabei** var. nov. [Figs. 73–78]

Amphigenous, or epiphyllous; mycelium usually evanescent, or (on the upper surface of the leaf) subpersistent, thin and effused, rarely forming definite spots; perithecia gregarious or more or

less scattered, globose-depressed, 70–120 μ in diam., aver. 95 μ, cells about 10 μ wide; appendages 11–48 in number, usually from 20–30, 1½ to twice the diameter of the perithecium, very rarely only equalling the diameter, simple, smooth or often rough towards the base, aseptate, thin-walled and hyaline above, often becoming refractive at the base, 4–6 μ wide, usually slightly enlarged upwards and about 6 μ wide, more or less abruptly flexuose or angularly bent in the upper half, sometimes irregularly swollen or sub-nodulose, apex simply uncinate, or frequently sub-helicoid; asci 4–7, broadly ovate to subglobose, with or without a short stalk, 40–56 × 30–38 μ; spores 4–6, or rarely 7, 19–21 × 10–12 μ.

Hosts.—*Alnus incana*, *A. maritima* (*A. Japonica*).

Distribution.—ASIA: Japan (Sapporo, K. Miyabe, October, 1890, September, 1894, September and October, 1895, on *Alnus Japonica;* G. Yamada, September, 1896, on *A. incana*).

The present plant shows some affinity with *U. geniculata* and *U. flexuosa* in the usually flexuose or angularly bent appendages, but in all other characters it is so closely allied to *U. salicis* that it seems best to place it a variety under this species. In the notes which Professor Miyabe sent with the specimens of Japanese *Erysiphaceae*, the present plant is thus referred to: "Related to *U. salicis*, but perithecia smaller (100 μ). Appendages fewer in number (22–30), slightly flexuose and nodose, longer (180–200 μ)." In certain forms of *U. salicis* on poplar, however, we meet with perithecia only 90 μ in diameter, with only from 15–30 appendages, which frequently reach to 2½ times the diameter of the perithecium. As a rule, however, *U. salicis* can be at once distinguished from the present variety by the larger size of the perithecia, which average 135 μ in diameter (those of the variety averaging 95 μ), and the more numerous appendages.

It is, however, by certain characters of the appendages that the var. *Miyabei* is best distinguished. If several perithecia are placed under the microscope, it will be seen that the appendages of by far the greater number are abruptly flexuose or angularly bent in the upper half, as shown in figs. 73, 74, 75, and in this respect are somewhat similar to those of *U. geniculata.* Further, the appendages of the var. *Miyabei* become, when mature, refractive and thick-walled at the base, whilst in the type, as far as I have seen, they invariably remain thin-walled throughout.

At first sight, the present variety appears to much resemble *U. geniculata*, but on closer comparison it is seen that in the latter species the appendages are always distinctly narrower, not enlarged upwards and more delicate.

Rarely, the appendages of the present plant are more or less regularly flexuose and not angularly bent; there is then some slight approach towards *U. flexuosa*, which differs in the shorter appendages, 8-spored asci, etc. Very rarely, and perhaps abnormally, a single appendage is found branched at the apex (figs. 76, 77).

The only example sent on *Alnus incana* differs from those on *A. Japonica* in the mycelium forming definite spots on the upper surface of the leaf. The perithecia are seated on these, and as a rule, although not invariably, are larger.

2. U. aceris (DC.) Sacc. [Fig. 87]

Mucor Erysiphe Linn. Sp. Pl. **2**: 1186 (partim). 1753.

Erysiphe aceris DC., Syn. Pl. Fl. Gall. 57. 1806; Duby, Bot. Gall. **2**: 870. 1830; Tul. Sel. Fung. Carp. **1**: 197. *pl. 2. f. 2, 3.* 1861; de Bary, Beitr. Morph. Phys. Pilz. **1**: § xiii., 52. 1870.

E. varium Fr. Obs. Myc. (partim) **1**: 206. 1815; **2**: 366. 1818.

Alphitomorpha bicornis Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 38. 1819; Wallr. Ann. Wett. Ges. **4**: 235. 1819; Wallr. Fl. Crypt. Ger. **2**: 755. 1833.

Erysibe aceris DC., Gray, Nat. Arr. Brit. Pl. **1**: 589. 1821.

E. bicornis (*acerum*) Lk.; Willd. Sp. Pl. **6**: 112. 1824; Rabenh. Krypt. Fl. Deutschl. **1**: 235. 1844.

Erysiphe bicornis Fr. Syst. Myc. **3**: 244 (partim). 1829; Berk.; Sm. Engl. Fl. **5**: 327. 1836; Corda, Icon. Fung. **2**: 28. *pl. 13. f. 100.* 1838.

Uncinula bicornis Lév. Ann. Sci. Nat. III. **15**: 153. *pl. 7. f. 17* (partim). 1851; Cooke, Micr. Fung. 219. *pl. 11. f. 225–228.* 1865; Cooke, Handb. Brit. Fung. **2**: 647. 1871.

U. aceris (DC.) Sacc. Syll. Fung. **1**: 8. 1882; Wint. in Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 41. 1884; Schroet. in Cohn's Crypt. Fl. Schles. **3**: 246. 1893; Jacz. Bull. l'Herb. Boiss. **4**:

738 (excl. syn. *U. Tulasnei* Fckl.). 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 88. 1897.

EXSICC.: Rab.-Wint. Fung. Eur. 2941; Brit. and Cav. Fung. par. 70; Rehm. Ascom. 77; Sacc. Myc. Ven. 146; de Thüm. Fung. austr. 133, and Myc. Univ. 154; and (cum *Phyllactinia corylea*) 1055; Syd. Myc. March. 143, *658, *3674, *4231; Kunze. Fung. select. exsicc. 236, 575; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 267, 1112; *ed. 2, ser. 1, 512; Vize. Fung. Brit. 197; and *198 sub *Microsphaera Hedwigii;* Westend. Herb. Crypt. Belg. 550; Cooke, Fung. Brit. Exsicc. 93, ed. 2, 282; Jack, Lein. and Stizenb. Krypt. Bad. 51; Ayres, Myc. Brit. 78; Roumeg. Fung. Gall. Exsicc. 971; Fckl. Fung. Rhen. 701; Klotzsch, Herb. Myc. 179; *Rab. Fung. Eur. 559; *Wartm. and Schenk. Schweiz. Krypt. 212; *Kneiff. and Hartm. Pl. Crypt. Bad. 14; Erb. Critt. Ital. ser. 2, 818, 1364 (in Herb. Mus. Florence).

Amphigenous; mycelium evanescent, or persistent as a thin effused film; perithecia scattered or subgregarious, hemispherical or globose-depressed, large, 120–225 μ in diameter, usually about 180 μ, cells ill-defined, about 10 μ wide; appendages numerous, ½–¾, rarely equalling the diameter of the perithecium, smooth, colorless, thick-walled to the apex, usually a very few simple, the rest bifid, with occasionally one or both of the branches again forked, apex of the simple appendages or of the branches uncinate; asci 4–12, usually 6–10, sub-pyriform or oblong, with or without a short stalk, 70–95 × 45–55 μ; spores usually 8, rarely 6, 22–26 × 13–15 μ.

Hosts.—Acer campestre, *A. monspessulanum*, *A. pictum*, *A. platanoides*, *A. pseudo-platanus*, *A. rubrum* (394), *A. spicatum*, *A. tataricum* [*Phillyrea media* (214)].

Distribution. — EUROPE: Britain, France, Belgium, Netherlands (263), Germany, Switzerland, Italy, Austria-Hungary, Denmark, Sweden, Russia.

ASIA: Transcaucasia (338), Japan.

U. aceris is recognized at once by its forked appendages (Fig. 87) which more or less cover the upper half of the perithecium, forming a kind of crown (see Tulasne's beautiful figures, Sel. Fung. Carp. **1**: *pl. 2. f. 2–3*).

Nearly all authors have described the perithecia as becoming

depressed, or pezizoid in age. This statement rests on a curious misconception. On looking at a leaf on which there are mature examples of *U. aceris* we nearly always find that some perithecia, as seen from above, appear very concave, or even cup shaped; a closer examination, however, shows that these are perithecia which have become turned over, so that the upper half, with the appendages which it bears, is pressed to the surface of the leaf. The base of the perithecium, thus exposed, soon loses all traces of mycelial hyphae, and becomes concave, simulating the truly "pezizoid" perithecia of such species as *Erysiphe taurica*. Whether this turning over of the perithecium is natural, and due to some growth of the mycelium or action of the appendages, or whether it is accidental, I am not able to say. The appendages, which through the turning over of the perithecium are pressed against the leaf, sometimes seem to become slightly attached to it, and it is noticeable that the apices of these appendages show, under the microscope, signs of having become slightly disorganized; they may possibly, therefore, adhere to the leaf through some mucilaginous degeneration. Observations on living plants are necessary before the question of how this curious reversal (already in 1861 observed by Tulasne (370)) of the perithecia takes place can be answered.

Acer campestre and *A. pseudo-platanus* are the usual host-plants of the present species; it is only very rarely indeed that *U. aceris* occurs on *A. platanoides*, being usually replaced on this host by the var. *Tulasnei*,* and it is not common on the other species of *Acer* mentioned (*A. monspessulanum*, *A. rubrum*, etc.). The Japanese examples occurred on *A. pictum* and *A. spicatum*, and are very interesting geographically.

As a rule, the simple appendages are very few in number, and more or less completely hidden by the very numerous forked ones; on *Acer tartaricum*, however, the simple appendages are numerous, and this form certainly shows an approach, in this respect, to the var. *Tulasnei*; the mycelial characters, however, are those of the type.

U. aceris is not known to occur in America; the only record

* Eriksson, however, states that he has frequently observed both these plants growing together on *Acer platanoides* in nurseries at Stockholm.

of its occurrence there, by Harkness and Moore (159) rests on an error.

Eriksson states (119) that the present species causes much damage to young trees of *Acer* in the nurseries at Stockholm, and recommends as preventive measures the collection and burning of the diseased leaves.

The conidial stage of the present species was described as *Oidium aceris* Rabenh. Flora, **12** : 207. 1854.

var. **Tulasnei** (Fckl.) [Figs. 90–92]

Mucor Erysiphe Schrank, Prim. Fl. Salisb. 240 (partim). 1792.

Erysiphe bicornis Fr. Syst. Myc. **3** : 244 (partim). 1829.

Erysibe aceris Wahl. Fl. Suec. **2** : 1086. 1833.

Uncinula bicornis Lév. Ann. Sci. Nat. III. **15** : 135 (partim). 1851.

U. Tulasnei Fckl. Fung. Rhen. ur. 1746. 1866; Fckl. Symb. Myc. 81. 1869–70; Sacc. Syll. Fung. **1** : 9. 1882; Wint. in Rabenh. Krypt. Fl. Deutschl. $\mathbf{1}^2$: 41. 1884.

EXSICC. : Fckl. Fung. Rhen. 1746; Syd. Myc. March., 2835, *4232, and 2764 sub *U. bicornis;* Rab. Fung. Eur. 1915; * de Thuem. Myc. univ. 644, and Fung. austr. 1251; * Erikss. Fung. par. scand. 35.

Mycelium usually epiphyllous, very rarely amphigenous, persistent, densely compacted, forming either roundish circumscribed spots, or irregular blotches following the veins of the leaf, often becoming confluent and covering the upper surface of the leaf; perithecia subgregarious or scattered, globose-depressed to lenticular, 156–268 μ in diameter, averaging 205 μ; appendages numerous, ½–¾ diameter of the perithecium, simple or bifid, (usually mostly simple intermixed with a few bifid ones), colorless, smooth, thick-walled, with the lumen nearly or wholly obliterated in the lower part; asci 8–20, broadly ovate or elliptic-oblong, 64–98 × 40–50 μ, averaging 80 × 43 μ; spores 8, rarely 6 or 7, 26–30 × 14–17 μ.

Hosts.—Acer monspessulanum, A. platanoides, A. pseudo-Platanus (176) (210).

Distribution.—EUROPE : France, Germany, Switzerland (176), Austria-Hungary, Norway, Sweden, Russia.

U. aceris, var. *Tulasnei* is somewhat variable in the nature of its appendages; sometimes these are all simple, when there is a

certain resemblance to *U. salicis*, from which it is distinct in its large size, usually 8-spored asci, and thick-walled appendages; sometimes many of the appendages are bifid, when an approach is made towards the type. In *U. aceris*, however, although simple appendages do occur, these are always very few in number, and rarely, if ever, as numerous as in the var. *Tulasnei* (see, however, note above). Moreover, the densely compacted persistent mycelium is never found in *U. aceris* type.

Fuckel first separated the present plant as a distinct species (*U. Tulasnei*), and gave in the diagnosis the character "conidiis concatenatis, perfecte globosis, 8 mik. diametr." Subsequent authors have repeated the statement, and have relied on this character as the chief one for separating the plant. Thus Saccardo (307) says of *U. Tulasnei*, "Praecipue habitu et conidiis globosis dignoscenda species," and Winter (394, p. 42), "Unterscheidet sich von *U. aceris* hauptsächlich durch die kugeligen Conidien, die bei jener, wie bei allen anderen *Uncinula* arten elliptisch sind."

Eriksson (119, *pl. 4. f. 10–12*) figures these small globular conidia, and contrasts them with the much larger conidia of *U. aceris* proper.

Examination of herbarium material makes me doubt whether authors have been right in regarding these bodies as the conidia of the present plant. In certain specimens I have found, on the same leaf, the two kinds of conidia represented in Figs. 90–92. Fig. 90 is evidently the form described by the above authors (cf. Eriksson's figures); the conidiophores are very small, and with the small more or less globose spores (about 8 μ in diameter) bear no resemblance to the *Oidium*-form of other members of the *Erysiphaceae*. The other form (Fig. 91), present in about equal numbers agrees closely with the figures of the conidia and conidiophores of *U. aceris* given by Eriksson (loc. cit., *f. 7, 8*). It is possible that the small form is some species of *Oospora* associated accidentally with the *Uncinula*.

The mycelial characters, which give the present plant so different an appearance from the type, we know to be of very slight systematic value (cf. remarks on "*Erysiphe densa* Berk)," and other characters seem hardly important enough to give a higher than varietal rank under *U. aceris*.

As to how far the present plant has been confused with *U. aceris*, it is almost impossible to say. Fries (130, p. 244) (1829) remarked under *Erysiphe bicornis*, "Species in *Acere platanoide* fruticosa obvia eminus a reliquis dignoscitur maculis suis crustosis, candidissimis, contiguis, determinatis, sericeis, semper epiphyllis. Thallus tam insignis in nulla alia observatur." This evidently applies to the var. *Tulasnei*. Léveillé, also (214), in 1851 included the present plant under his *Uncinula bicornis*, as his description and remarks on p. 154 show: there is also a specimen of the var. *Tulasnei* in Berkeley's herbarium at Kew, named in Léveillé's handwriting *U. bicornis* (see also Tulasne (370, p. 197).

Acer platanoides is the usual host-plant for the present species, and on this tree it appears to be not uncommon on the Continent. It sometimes however occurs on *A. monspessulanum* (*A. trilobatum*), and Jaczewski (176) and Le Breton and Niel (210) have recorded it on *A. pseudo-Platanus*.

Eriksson (119, p. 7) records the present variety as often occurring with *U. aceris* on the same plant of *Acer platanoides*, and states that it causes great damage to this tree in the neighborhood of Stockholm, not only to young plants in nurseries, but also to large trees.

3. U. PRUNASTRI (DC.) Sacc. [Figs. 79, 80]

Erysiphe prunastri DC. Fl. Fr. **6**: 108. 1815; Tul. Sel. Fung. Carp. **1**: 199. 1861; de Bary, Beitr. Morph. Phys. Pilz. **1**: § xiii., 50. 1870.

Alphitomorpha adunca, var. *prunastri* Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 37. 1819.

A. prunastri Wallr. Ann. Wett. Ges. **4**: 237. 1819.

Erysibe adunca, var. *prunastri* Lk. Willd. Sp. Pl. **6**: 112. 1824.

Erysiphe adunca, var. *prunastri* Fr. Syst. Myc. **3**: 245. 1829; Duby, Bot. Gall. **2**: 870. 1830.

Alphitomorpha adunca, var. *rosacearum* Wallr. Fl. Crypt. Germ. **2**: 755 (partim). 1833.

Erysiphe adunca Fr. Kickx. Fl. Crypt. Erw. Louv., **139**: (partim). 1835.

Erysibe adunca, var. *rosacearum* Rabenh. Krypt. Fl. Deutschl. **1**: 236 (syn. excl. partim). 1844.

Uncinula Wallrothii Lév. Ann. Sci. Nat. III. **15**: 153. *pl.* 7. *f.* 16. 1851; Cooke, Handb. Brit. Fung. **2**: 647. 1871.

U. prunastri (DC.) Sacc. Syll. Fung. **1**: 7. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. $\mathbf{1}^2$: 41. 1884; Schroet.; Cohn's Krypt. Fl. Schles. **3**: 245. 1893; Jacz. Bull. l'Herb. Boiss. **4**: 742. 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 87. 1897.

EXSICC.: De Thüm. Myc. univ. 1450; Cooke, Fung. Brit. Exsicc. 217; ed. sec. 281; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 1306; *ed. 2, ser. 1, 706; Roumeg. Fung. Gall. Exsicc. 3649; Roumeg. Fung. Sel. Exsicc. 4928; Rab. Fung. Eur. 2133; Syd. Myc. March. 835, *3823; Fckl. Fung. Rhen. 1747; *de Thüm. Fung. austr. 463; *Sacc. Myc. Ven. 616; *Erb. Critt. Ital. ser. 2, 831 (cum *Podosphaera oxyacanthae* var. *tridactyla*); *Rab. Herb. myc. ed. 2, 758; *Erikss. Fung. par. scand. 140; Westend. Herb. Crypt. Belg. 969 (in Herb. Jard. bot. Bruxelles).

Amphigenous; mycelium evanescent; perithecia gregarious or scattered, very variable in size, from 80–146 μ in diameter, usually about 105 μ, globose-depressed, cells about 10 μ wide, somewhat translucent; appendages very variable in number, from 12–60, 1 ¼ to twice the diameter of the perithecium, rough (rarely smooth) and thick-walled below, thin-walled above, colorless, aseptate, slightly enlarged upwards to a simply uncinate apex measuring about 18 μ across; asci 7–18, ovate or elliptic-oblong, very shortly stalked, 42–58 × 24–30 μ; spores 5–7, 16–20 × 8–10 μ.

Hosts.—*Prunus insititia, P. pumila, P. spinosa* [*Crataegus* (338)].

Distribution.—EUROPE: Britain, France, Belgium, Netherlands (263), Germany, Switzerland (176), Italy, Austria-Hungary, Denmark, Norway, Sweden.

[ASIA: Transcaucasia (338)].

A very variable species in the size of the perithecium and number of the appendages. When the latter are few, *U. prunastri* recalls, by the rough base and enlarged apex of the appendages, *U. clandestina*, but that species is distinct in the 2–3-spored asci; when the appendages are numerous the present species approaches *U. salicis*, to which, of the European members of the genus, it is most allied, differing in the smaller perithecia and asci, the thick-walled and nearly always rough base of the appendages, and the smaller, usually 6-spores. The real affinity of *U. prunastri* is, however, with *U. Clintonii* (see remarks under that species).

U. prunastri has hitherto been recorded on a single host-plant, *Prunus spinosa*. I have, however, found examples contained in the Herbarium of the Upsala Museum, on *P. pumila*, and have also lately seen specimens growing on *P. insititia*, from France (Bagnères de Bigorre, Pyrenees, 2000′ J. H. Burkill, Aug., 1899).

There is a specimen, in Cooke's Herbarium, at Kew, labelled "*U. Wallrothii*, f. *Lonicerae Xylostei*, M. Cerva. Belluno. 18" in Professor Saccardo's handwriting. On the honeysuckle leaves there are certainly several perithecia of *U. prunastri*, but there is no evidence to show that these grew there. The perithecia appear to be all merely entangled in the leaf-hairs, and not fixed, and on the slight traces of mycelium present on the leaf I could find no signs of young perithecia.

Speschnew (338) records *U. prunastri* from Transcaucasia with the following note. "Le distingue du précédente [*U. salicis*] par 6 spores dans chaque ascus et a été trouvé sur une espèce de *Crataegus*, au parc de Tzinondaly, en septembre."

U. prunastri has been recorded from America, by E. C. Howe, in Cooke and Peck's "Erysiphei of the United States (91, p. 170), by Bessey (40, p. 7), and in Farlow and Seymour's Host-Index (125, p. 15), but the specimens referred to are all *U. necator;* the same is also the case with the specimen in Ravenel's Herbarium at the British Museum (S. Kensington) labelled "*U. Wallrothii* Lév. on *Ampelopsis*, Pennsylvania, Dr. Michener, ex Curtis."

4. U. CLANDESTINA (Biv. Bern.) Schroet. [Fig. 93]

Erysiphe clandestina Biv. Bern. Stirp. Rar. Sic. man. **3**: 20. *pl. 4. f. 4.* 1815.

Alphitomorpha adunca, var. *ulmorum* Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 37. 1819; Wallr. Fl. Crypt. Germ. **2**: 755. 1833.

Erysibe adunca, var. *ulmorum* Lk. in Willd. Sp. Pl. **6**: 112. 1824; Rabenh. Krypt. Fl. Deutschl. **1**: 236. 1844.

Erysiphe adunca Fr. Syst. Myc. **3**: 245 (partim). 1829.

E. ulmi Cast. Cat. Pl. Mars. **192**: 1845.

E. adunca, var. *ulmorum* Dur. & Mont., Fl. d'Algér. (Crypt.) **567**: 1846–9.

Uncinula Bivonae Lév. Ann. Sci. Nat. III. **15**: *pl. 7. f. 14.* 1851; Sacc. Syll. Fung. **1**: 6. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 40. 1884; Jacz. Bull. l'Herb. Boiss. **4**: 741. 1896.

Erysiphe Bivonae Tul. Sel. Fung. Carp. **1**: 200. 1861.

Uncinula clandestina (Biv. Bern.) Schroet.; Cohn's Krypt. Fl. Schles. **3**: 245. 1893.

EXSICC.: Rab. Fung. Eur. 2030; Fckl. Fung. Rhen. 698; Rehm. Ascom. 400; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 920, and *ed. 2, ser. 1, 220; Sacc. Myc. Ven. 617; de Thüm. Myc. univ. 755; Rab. Herb. Myc. ed. 2, 466; *Wartm. & Wint. Schweiz. Krypt. 824.

Amphigenous: mycelium evanescent, or subpersistent as a very thin effused film; perithecia closely gregarious in small patches, or scattered over the surface of the leaf, rounded-lenticular, 85–115 μ in diameter, averaging 95 μ, cells 10–14 μ wide: appendages few, 9–25, rarely 25–30, usually about 15, equalling or (usually) slightly exceeding the diameter of the perithecium, simple, colorless, aseptate, or occasionally septate near the base, thick-walled and usually rough below, thin-walled and swollen into a somewhat club-shaped apex above; asci usually 4, rarely 3, 5, or 6, broadly ovate to globose, with or without a very short stalk, 40–45 × 32–40 μ, averaging 45 × 35 μ; spores 2, very rarely 3, 30–34 × 15–18 μ, sometimes slightly curved.

Hosts.—Ulmus campestris, U. montana.

Distribution.—EUROPE: England (239), France, Belgium (209), Germany, Switzerland, Italy, Austria-Hungary, Poland.

AFRICA: Algeria.

ASIA: Japan.

A well-marked species in the few, somewhat club-shaped appendages and the 2-spored asci.

U. clandestina is not known to occur in America, all the records of its occurrence in the United States being erroneous, and mostly referring to *U. macrospora*. The plant recorded as *U. Bivonae* by Cooke and Peck (90, p. 11) is *U. Clintonii*, and the host-plant is *Tilia Americana*, not *Ulmus* as stated. The claim of *U. clandestina* to be considered as British rests on the authority of Cooke, who records (239) this species as growing on the elms in the Royal Gardens, Kew; I cannot, however, find specimens from this locality in this author's herbarium at Kew. The African

(Algerian) specimen is in Montagne's herbarium in the herbarium of the Paris Museum. The Japanese example (now in the Kew Herbarium), on *Ulmus campestris*, was sent to me by Prof. Miyabe, and agrees perfectly with European specimens. This is the first record of *U. clandestina* from Asia.

5. U. NECATOR (Schwein.) Burr. [Fig. 86]

Erysiphe necator Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1**: 22. 1882.

E. Tuckeri Berk. Journ. Hort. Soc. Lond. **9**: 66. 1855; de Bary, Beitr. Morph. Phys. Pilz. **1**: § xiii. 50. 1870; Sacc. Syll. Fung. **1**: 20. 1882; Wint. in Rabenh. Krypt. Fl. Deutschl. 1^2: 34. 1884.

Sphaerotheca Castagnei, var. *vitis* Fckl. Symb. Myc. 79. 1869–70.

Uncinula Americana E. C. Howe, Journ. of Bot. II. **1**: 170. 1872; Sacc. Syll. Fung. **1**: 8. 1882.

U. spiralis Berk. & Curt. Grevillea, **4**: 159. 1876; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 66. 1891; Jacz. Bull. l'Herb. Boiss. **4**: 739. 1896.

U. subfusca Berk. & Curt. Grevillea, **4**: 160. 1876.

U. spiralis, var. *racemosum* Thüm. Pilz. des Weinst. 12. 1878.

U. ampelopsidis Peck, Trans. Albany Inst. **7**: 216. *f. 16–18*. 1872; Peck, Reg. Rep. **25**: 96. 1873; Sacc. Syll. Fung. **1**: 7. 1882; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 406. *f. 5*. 1887.

U. necator (Schwein.) Burr.; Ell. & Ever. N. Amer. Pyren. 15. 1892.

Erysibe Tuckeri (Berk.) Schroet.; Cohn's Krypt. Fl. Schles. **3**: 241. 1893.

EXSICC.: Rab.-Wint. Fung. Eur. 3745; Ellis, N. Amer. Fung. 133; de Thuem. Myc. univ. 1143, 19, 38; Roumeg. Fung. sel. Exsicc. 4757; * Seym. and Earle, Econ. Fung. 4, 5; * Ell. and Everh. Fung. Columb. 415; * de Thuem. Pilz. des Weinst. 5.

Amphigenous, mycelium usually subpersistent, very thin and effused, or forming circumscribed patches, sometimes evanescent: perithecia usually epiphyllous, sometimes hypophyllous, occasionally occurring on the inflorescence, globose-depressed, more or less scattered, 70–128 μ in diameter, averaging 98 μ, cells distinct,

rather irregular in shape, 10–20 μ wide, appendages very variable in number and length, 7–32, rarely irregularly crowded and as many as 40, 1–4 times the diameter of the perithecium, smooth, simple, septate, thin-walled, light or dark amber-brown in the lower half, flexuous and flaccid when long, subrigid and straight when shorter, apex more or less helicoid when mature, often strongly so: asci 4–6, rarely 6–9, broadly ovate or ovate-oblong to subglobose, with or without a short stalk, 50–60 × 30–40 μ; spores 4–7, 18–25 × 10–12 μ.

"Hyphasma, tenuissimum album, floccis valde tenuibus, orbiculatum, non constringens. Sporangiolis minutissimis, raris, fusco-nigris, globosis. Ubi omnino evoluta, etiam haec species destruit uvas . . . in uvis *Vitis Labruscae* varietatibus cultis in vineis nostris" (Schwein, *loc. cit.*).

Hosts.—Actinidia arguta, A. Kolomikta, A. polygama, Ampelopsis cuspidata (60), *Vitis aestivalis* (60), *V. Californica* (373), *V. cordifolia* (97) (249), *V. flexuosa, V. hederacea* (*Ampelopsis quinquefolia*), *Vitis Labrusca* and var. *Catawba, V. riparia* (60), *V. rupestris* (373), *V. vinifera.*

Distribution (of perithecial form only).—EUROPE: France.

ASIA: Japan.

NORTH AMERICA: United States—Maine, Massachusetts, New York, Pennsylvania, Maryland, New Jersey, West Virginia (249), Ohio, Michigan, Indiana, Alabama (12), Illinois, Mississippi, Wisconsin, Missouri, Iowa, Kansas, Texas (373), New Mexico, South Dakota (151), California. Canada—Ontario.

Uncinula necator is at once known by the colored appendages, which are, however, very variable in number and length.

The form on *Vitis hederacea* (*Ampelopsis quinquefolia*) is the *Uncinula ampelopsidis* of Peck (*U. subfusca* Berk. and Curt.) and at first sight seems to be distinct in the shorter, fewer (7–22) appendages, 1–3, usually 1½ times the diameter of the perithecium, not flexuous nor flaccid, and distinctly wider both in the lower half (7–8 μ wide), and towards the apex (8–10 μ). These characters are shown by most forms on this host-plant, and were they confined to this might entitle the plant to a varietal rank. But, as most American mycologists now admit, they are not so. In the ordinary examples of *U. necator* on *Vitis Labrusca, V. vinifera,* etc., the long appendages are about 5 μ wide, flexuous and weak, but

in the forms where the appendages tend to become shorter they also immediately become wider, more rigid, and less flexuous, and one is finally forced to the conclusion that "*U. ampelopsidis*" is but the last member of a chain of closely connected forms.

The occurrence of *U. necator* on species of *Actinidia*—a genus of plants belonging to Ternstroemiaceae, an order in no way related to Vitaceae—is very interesting, not only because the vine mildew has hitherto been supposed to be confined to vines, but also for the evidence it gives on the question, mentioned below, of the native country of *U. necator*. Professor Miyabe sent me numerous specimens (now in the Kew Herb.) of this form from Japan as "*Uncinula actinidiae*" Miyabe mss., but on examination the specimens proved to agree well with certains forms of *U. necator* from America. Some of the Japanese specimens have perithecia with few (about 8), short, wide appendages, 1–1½ times the diameter of the perithecium; others have more numerous, sometimes irregularly crowded appendages, up to 28 in number, flaccid and three times the diameter of the perithecium. These Japanese specimens further strengthen the view that no sharp line can be drawn between the long- and short-appendaged forms of the present plant. Some of the appendages of the Japanese specimens show a distinctly swollen base (Fig. 86). The apex of the appendages, when mature, is strongly helicoid.

U. necator, or "*Oidium Tuckeri*" as the conidial stage has long been called in Europe, is well known as the vine mildew, a disease which has caused the most serious injury to cultivated vines in both the Old and the New World. The literature concerning "*Oidium Tuckeri*," dealing with its systematic position, until quite recently a matter of doubt, its appearance, mode of attack, remedies, etc., is so vast that only a few references to the most important works can be given here. Briefly, the history of this vine mildew is as follows: In 1847 Berkeley (27) wrote in the Gardeners' Chronicle that "The grapes in the neighborhood of Margate (England) have for the two last years been attacked by a peculiar mildew of a most destructive character." Berkeley named the fungus *Oidium Tuckeri*, but even here hinted of its connection with an *Erysiphe*. The disease appeared almost immediately in all the vineyards of the Mediterranean region, and by 1851 it had been

observed in France, Switzerland, Germany, Italy, Asia Minor, Syria, Algeria, etc.; in 1852 it caused wholesale destruction in Madeira; in 1866–7 it was recorded from Australia; it is common throughout the United States, has lately occurred in Brazil and has been reported on vines in Japan; it is now, in fact, a disease almost certain to appear wherever grapes are grown.

Fortunately, a cheap and reliable remedy has been found against the vine mildew in the form of sulphur (flowers of sulphur, or solutions of the sulphide), and the disease is now held completely in check by means of the use of this fungicide. Galloway (137) (138) recommends the following method: In applying the sulphur, bellows should be used, and the first applications should be made ten or twelve days before the flowers open, the second when in full bloom, and a third three weeks or a month later if the disease seems to be on the increase. The best results are obtained when the applications are made with the thermometer ranging from 80° to 100° F. In this temperature fumes are given off, which quickly destroy the fungus. We have obtained excellent results in treating this disease with a solution made by dissolving half an ounce of potassium sulphide to the gallon of water. (In preparing the solution, half an ounce of the "liver of sulphur" was dissolved in one pint of hot water; as soon as dissolved, the cold water (1 gallon less 1 pint) was poured with the hot solution, and the whole immediately strained through a thick osnaburg cloth into a tin can and closely stopped.) This preparation is cheap and can be quickly and effectually applied with any of the well-known spraying pumps. The greatest care should be exercised in making the second spraying, which should be at the same time as that mentioned for the flowers of sulphur, in order to protect the blossoms from the fungus. For other preparations, and their method of application, etc., reference may be made to Viala (373).

It is important to distinguish clearly between the two diseases that have been called the "vine disease" or "vine mildew," the one due to the attacks of "*Oidium Tuckeri*," the other to those of *Peronospora viticola*, as the remedies for the latter (Bordeaux mixture, l'eau céleste, sulphate of copper) have been found to be of no effect against *Oidium Tuckeri*. It is therefore well to adopt the

distinctive names proposed by Riley for these two diseases, and now generally in use in America, viz., powdery vine mildew for *U. necator* (*Oidium Tuckeri*) and downy vine mildew for *Peronospora viticola*.

Although *Oidium Tuckeri* was so terribly prevalent in Europe since its appearance in 1845–6, no perithecia were found associated with it for the first 47 years of its occurrence, and during this time its true systematic position was much questioned. Berkeley (32), recognizing its close resemblance to the conidial stage of species of *Erysiphe*, changed the name in 1855 to *Erysiphe Tuckeri*. When, however, the *Uncinula* on the American vines became generally known, it began to be suggested that "*Oidium Tuckeri*" might be merely the conidial stage of this fungus; and Farlow (121) and Viala and Ravaz (375) among others pointed out the exact resemblance of the American and European *Oidium* forms. Many mycologists, however, would not admit the identity of the two, contending that the *Oidium Tuckeri* of the Old World had larger conidia than those of the American *U necator*. Fuckel considered *Oidium Tuckeri* to be the conidial condition of a variety of *Sphaerotheca Castagnei;* whilst others believed it to be that of *Erysiphe communis* (*E. polygoni*). In 1844 Berkeley recorded (37) the occurrence of a species of *Erysiphe*, apparently identical with *E. communis*," growing with *U. necator* on Vine leaves sent from Washington. [This was probably either a stray perithecium of *E. polygoni*, or probably immature examples (with young straight appendages) of *U. necator*.] However, in 1892 Couderc (93) discovered in several places in France, perithecia on vines attached by "*Oidium Tuckeri*," and showed that they were identical with those of *U. necator*. In the following year Viala (1894) reported an abundant formation of perithecia of *U. necator*, or diseased vines in many parts of France. This unusual production of the perithecial stage has been attributed to the sudden alternation of high and low temperatures which took place in these years. Through the kindness of Mr. Jaczewski I have seen specimens (now in the Kew Herbarium) of French examples of *U. necator* and have found them to agree in every way with American examples of this species.

Mycologists, *e. g.*, de Bary, von Mohl, Viala, Worthington G.

Smith—have considered that "*Oidium Tuckeri*"—the conidial stage of *U. necator*—was originally brought from the vines of America to Europe, and thus introduced at once spread over all the Mediterranean vineyards, but that from some cause due to the effect of the change of environment, the fungus lost the power of producing perithecia. Several fungous diseases are now known to have been introduced in this way from America to Europe, and so long as America was the only native country known for *U. necator*, the idea of the American origin of "*Oidium Tuckeri*" was natural, although it appears that no direct evidence on the point exists; now, however, that we know that *U. necator* is native to the Old World, occurring on native plants in Japan, it is a question whether it may not have invaded Europe from the East. *Vitis vinifera* is wild in western temperate Asia (and perhaps in the Mediterranean region), being especially frequent in Armenia, Caucasia, and the region round the Caspian Sea, and it is possible that *U. necator* will be found to occur in wild vines in these countries. It is, of course, possible that "*Oidium Tuckeri*" existed on European vines before the great outbreak of it in 1847–52—and there is some evidence favorable to this view—but that, at this time, for some unknown reason it first increased to such an extent as to form a dangerous disease. (For further details of the history of "*Oidium Tuckeri*" reference can be made to the following authors: Viala (373), von Mohl (250, 251, and 252) and Montagne (254).

As it appears that the formation of perithecia is exceptional in *U. necator* on European vines, the question presents itself as to how the fungus, in this absence of ascospores, bridges over the period of winter. It has been stated this is effected by a hibernating mycelium; other authors, *e. g.*, Viala, suppose that the conidia have acquired the power of being able to hibernate.

It is worth noting that Viala tried many experiments with the view of seeing if vines could be infected with the conidia of *Erysiphe polygoni*, and conversely, if the host-plants of *E. polygoni* could be attacked by "*Oidium Tuckeri*," but with negative results in both cases.

Galloway (139) has made some valuable observations on the ripening of the perithecium and the germination of the ascospores of the present species. Infected leaves of *Ampelopsis* and *Vitis*

were placed in the autumn in sacks on the open ground. Although the appendages of the perithecium soon disappeared, the asci and spores underwent little change until the end of December, when many of them were found to be dead or more or less collapsed. All attempts to germinate the ascospores before January failed, and it was only after repeated trials through February and March that success was attained. The perithecia were from time to time removed from the leaves and placed in a drop of sterile water in Van Tieghem cells. In one instance, which may be taken as typical of the usual development, some perithecia were placed in cells on January 7th. Twenty days later no change had taken place, the cell having been kept free from jars. The cell was then placed under the microscope, and gently jarred with a needle, whereupon one of the perithecia suddenly burst and the asci escaped into the surrounding water. The first ascus was violently ejected from the perithecium to a distance equal to about twice the length of the former. This was immediately followed by a second and a third ejected in the same way. The ruptured wall of the perithecium then closed and no more asci escaped. No sooner were the asci free than their spores began to escape or else to break up within the ascus. In the former case they escaped from the top, side or bottom of the ascus. A large part of the spores burst as soon as they were set free. Nearly all the spores that failed to burst began to send out germ tubes in four or five hours, and at the end of twelve hours the tubes had reached a length twice that of the spore or more. A number of attempts were made to infect leaves with ascospores, but the results were in every case negative.

6. U. CIRCINATA Cooke & Peck

U. circinata Cooke and Peck, Journ. of Bot. II. **1** : 12. 1872; Peck, Trans. Albany Inst., **7** : 214. *f. 7–9*. 1872; Peck, Reg. Rep. **25** : 96. 1873; Sacc. Syll. Fung. **1** : 8. 1882; Burr and Earle, Bull. Ill. State Lab. Nat. Hist. **2** : 408. 1887; Burr.; Ell. & Everh. N. Amer. Pyren. 17. 1892.

EXSICC.: Ell. N. Amer. Fung. 427; de Thüm. Myc. Univ. 2051; Roumeg. Fung. select. exsicc. 4927; Ell. and Everh. Columb. Fung. 110; *Seym. and Earle, Econ. Fung. 115, 116.

Hypophyllous, rarely amphigenous; mycelium evanescent, or subpersistent on the upper surface of the leaf and sometimes forming definite spots; perithecia usually scattered, sometimes gregarious, rounded-lenticular, 160–225 μ in diameter, rarely only 125–160 μ, averaging 190 μ, cells obscure, irregular, 10–14 μ wide; appendages very numerous, usually densely crowded, just falling short of the diameter of the perithecium, simple, smooth, aseptate, rather delicate, about 5 μ wide, thin-walled and hyaline throughout, apex simply uncinate; asci 9–26, usually about 15, narrowly ovate or cylindrical, sometimes ovate-oblong, with or without a short stalk, 68–86 × 29–40 μ; spores 8, sometimes 7, 18–22 × 10–14 μ.

Hosts.—*Acer dasycarpum*, *A. Pennsylvanicum* (60), *A. rubrum*, *A. saccharinum*, *A. spicatum*.

Distribution.—North America: United States—Maine (163), Vermont, Massachusetts, New York, Pennsylvania, South Carolina Ohio, Michigan, Indiana, Alabama, Illinois, Wisconsin, Missouri (363), Iowa. Canada—Ontario.

"This species is related to *U. bicornis* [*U. aceris*], from which it is distinguished by its hypogenous habit, more numerous sporangia and always simple appendages. It usually occupies the whole under-surface of the leaf." (Peck, 25 Rep.)

This distinct and endemic species, which apparently takes the place of the European *U. aceris* on the maples of North America, is somewhat intermediate between *U. aceris* and *U. salicis*, agreeing with the former species in the 8-spored asci and large perithecia, and with the latter in the numerous, simple, thin-walled appendages. From *U. aceris*, var. *Tulasnei* it differs in the more or less evanescent mycelium, and thin-walled appendages. When well-developed the appendages cover the whole of the upper half of the perithecium.

7. U. parvula Cooke & Peck

U. parvula Cooke & Peck, Journ. of Bot. II. **1**: 170. 1872; Burr & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 409. 1887; Sacc. Syll. Fung. **9**: 367. 1891; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 67. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 18. 1892.

U. Torreyi Gerard, Trans. Albany Inst. **7**: 215. 1872.

Amphigenous; mycelium evanescent; perithecia usually hypophyllous, scattered, globose-depressed, small, 86–122 μ in diameter, averaging 98 μ, cells about 10 μ wide; appendages numer-

ous, 50–160, ½–¾ the diameter of the perithecium, simple, colorless, aseptate, becoming more or less thick-walled throughout, smooth, delicate, 3–4 μ wide, slightly attenuated upwards, apex simply uncinate; asci 5–8, broadly ovate with or without a short stalk, 50–64 × 34–38 μ; spores 4–7, usually 6, 20–24 × 10–12 μ.

Hosts.—*Celtis Americana, C. occidentalis.*

Distribution.—NORTH AMERICA: United States—New York, New Jersey, South Carolina, Indiana, Alabama (12), Illinois, Mississippi, Missouri, Iowa, Kansas (386), Washington. "From the Atlantic coast to Washington; not apparently abundant, but often collected from widely separated localities" (Burrill (60)).

An interesting species (endemic to North America), distinct from *U. salicis* in the small perithecia with shorter, more delicate and narrower appendages, which become more or less solid through obliteration of the lumen at maturity.

8. U. MACROSPORA Peck

U. macrospora Peck, Trans. Albany Inst. **7**: 215. *f. 4–6.* 1872; Peck, Reg. Rep. **25**: 96. 1873; Sacc. Syll. Fung. **1**: 7. 1882; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 407. 1887; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 66. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 18. 1892.

U. intermedia Berk. & Curt. Grevillea, **4**: 160. 1876; Sacc. Syll. Fung. **1**: 7. 1882.

EXSICC.: Ell. N. Amer. Fung. 426; de Thüm. Myc. Univ. 2053; Rab.-Wint. Fung. Eur. 3244; *Seym. & Earle, Econ. Fung. 154, 156a, 156b; *Ell. & Everh. Fung. Columb. 223, 414.

Amphigenous; mycelium evanescent, or subpersistent and pruinose, rarely forming circumscribed patches on the upper surface of the leaf; perithecia closely gregarious in small patches, or scattered over the surface, globose-depressed or lenticular, 95–165 μ in diameter, averaging 130 μ, cells about 10 μ wide; appendages numerous, 50–130 or more, varying in length from ⅓ the diameter of the perithecium to a little more than its diameter, smooth, colorless, aseptate, simple, thick-walled at base, thin-walled above, not or scarcely enlarged upwards, apex usually simply uncinate, but sometimes subhelicoid; asci 8–14, rarely 14–20, sub-pyriform or elliptic-oblong, often curved, 54–65 × 29–35 μ; spores 2, 30 × 15–18 μ.

Hosts.—Ostrya Virginica, Ulmus alata, U. Americana, U. fulva.

Distribution.—NORTH AMERICA: United States—Massachusetts, New York, North and South Carolina, Ohio, Michigan, Indiana, Alabama, Illinois, Mississippi, Wisconsin, Missouri (363), Iowa, Kansas, South Dakota (151).

Quite distinct from *U. Bivonae*, its nearest ally, in the larger perithecia, with more numerous appendages and asci. *U. Bivonae* is frequently recorded as occurring in America, but this is incorrect, and the specimens so named have proved (with one exception) to belong to the present species.

9. U. FLEXUOSA Peck. [Figs 83, 84]

U. flexuosa Peck, Trans. Albany Inst. **7**: 215. *f. 10–12.* 1872; Sacc. Syll. Fung, **1**: 8. 1882; Burr & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 408. 1887; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 66. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 16. 1892.

EXSICC.: de Thüm. Myc. Univ. 2052; Ell. N. Amer. Fung. 661; Rab.-Wint. Fung. Eur. 3658; *Seym. & Earle, Econ. Fung. 118a, 118b; *Ell. & Everh. Fung. Columb. 416.

Hypophyllous, or sometimes amphigenous; mycelium evanescent or under surface of leaf, but sometimes subpersistent in very thin patches on the upper surface; perithecia more or less scattered, rounded-lenticular, 85–156 μ in diameter, averaging 100 μ, cells distinct, averaging 17 μ wide; appendages variable in number, 14–60, usually about 30, about equalling the diameter of the perithecium, simple, colorless, and aseptate, hyaline, enlarged, and abruptly flexuose upwards, becoming refractive and thick-walled, and often rough below; asci 4–11, broadly ovate, with a short stalk, 50–58 × 30–38 μ; spores usually 8, sometimes 7 or (rarely) 6, 18–22 × 10 μ.

"The flexuose appendages are characteristic of this species. They sometimes appear as if twisted like the blade of a screw-auger" (Peck, loc. cit.).

Hosts.—Aesculus arguta (386), *A. flava* (60), *A. glabra, A. Hippocastanum, A. Pavia.*

Distribution.—NORTH AMERICA: United States—Massachusetts, New York, New Jersey, South Carolina, Ohio, Indiana, Alabama, Illinois, Mississippi (361), Missouri, Kansas (386). Canada—Ontario.

Very variable in the size of the perithecia and number of the appendages, but easily recognized by the abruptly undulated upper half of the appendages (Fig. 83) and the usually 8-spored asci.

Saccardo's description of *U. flexuosa*, "peritheciis 80–90 μ d., appendicibus 15–25" applies only to the small form of the species, such as, for instance, the specimen in the Kew Herbarium from South Carolina ("C. H. P., 192"), where the perithecia are frequently only 90 μ in diam., with 25 or fewer appendages. Peck and Saccardo compare *U. flexuosa* with *U. salicis*, but there is no close relationship between these two species, and it is *U. Clintonii* that is undoubtedly the nearest ally to the present species. The small forms of *U. flexuosa*, mentioned above, approaches certain examples of *U. Clintonii* very closely, and can only be separated by the—in this form—slightly-undulated appendages, which are shorter, and by the 8-spored asci.

10. U. CLINTONII Peck. [Figs. 81, 82]

U. Clintonii Peck, Trans. Albany Inst. **7**: 216. *f. 13–15.* 1872; Peck, Reg. Rep. **25**: 96. 1873; Sacc. Syll. Fung. **1**: 7. 1882; Burr.; Ell. & Everh. N. Amer. Pyren. 15. 1892.

EXSICC.: Ell. N. Amer. Fung. 662; *Seym. & Earle, Econ. Fung. 105; *Rab.-Wint.-Pazsch. Fung. eur. 4051; *Ell. & Everh. Fung. Columb. 413.

Hypophyllous, or amphigenous; mycelium usually evanescent, sometimes sub-perisistent; perithecia gregarious or scattered, 80–130 μ in diameter, rarely only 64–86 μ (on *Zelkova*), cells rather irregular in shape, 10–20 μ wide; appendages 10–35, or rarely as few as 7, usually about 20, 1–2, rarely 2½ times the diameter of the perithecium, often unequal in length on the same perithecium, simple, colorless or sometimes brownish-amber at base, refractive, thick-walled and often rough below, smooth, thin-walled and swollen above, measuring 20–30 μ across the simply uncinate clavate apex; asci 4–10, or 2–4, usually 3 (on *Zelkova*), broadly ovate to subglobose, very shortly stalked, 40–62 × 34–40 μ.; spores 3–7, usually 5–6, more or less crowded in the ascus, 20–25 × 10–13 μ.

Hosts.—Aphananthe aspera, Tilia Americana, Zelkova acuminata.

Distribution.—ASIA: (on *Aphananthe* and *Zelkova*) Japan.

North America: (on *Tilia*) United States: New York, Maryland, Ohio, Michigan, Indiana, Illinois, Wisconsin, Iowa, Minnesota. Canada—Ontario.

This species shows great affinity with the European *U. prunastri*, from which it differs in the usually fewer and always broader asci, larger spores, and usually more swollen apex of the appendages. With regard to the last character, however, there is certainly much variation, as a glance at Fig. 81 will show, and it would be unsafe to place any great value on this point.

U. Clintonii has been hitherto regarded as confined to North America, where it occurs not unfrequently on the single host-plant, *Tilia Americana*. Among the Japanese specimens of Erysiphaceae, however, sent to me by Professor Miyabe there occurs an *Uncinula*, which, although differing slightly from the American examples must, I think, be included under the present species. Two specimens were sent, one on *Zelkova acuminata* (*Z. Keaki*) from Kobe, (K. Miyabe, Aug. 1889), the other on *Aphananthe aspera* from Tokyo (K. Sengoku, Oct. 1898).

The first specimen sent was that on *Zelkova*, and as this differed in several characters from the American form, I was at first inclined to rank it as a variety *minor* under *U. Clintonii*. The specimens showed these characters: mycelium epiphyllous, subpersistent, very thin, effused; perithecia uniformly scattered over the upper surface of the leaf, small, 64–86 μ in diameter, averaging 78 μ, cells 10–20 μ wide; appendages 12–25, unequal in length, from equalling to twice exceeding the diameter of the perithecium, colorless, simple, thick-walled, refractive and narrow (about 4 μ wide) at the base, thin-walled and enlarged upwards, about 20 μ wide across the simply uncinate apex; asci 2–4, usually 3, 40–50 $\times$ 34–40 μ, subglobose, with or without a very short stalk; spores 3–5, crowded in the ascus, 20–24 $\times$ 10–12 μ.

This "var. *minor*" could be thus contrasted with the American plant: *U. Clintonii* (American); perithecia 80–130 μ in diameter, appendages 22–30 μ wide across the apex, asci 4–10. "Var. *minor*" (Japanese); perithecia 64–86 μ in diameter, appendages about 20 μ wide across the apex, asci 2–4, usually 3.

The second Japanese specimen sent (on *Aphananthe*), however, broke down these distinctions, as this form has perithecia 75–

100 μ in diameter, appendages 20 μ wide across the apex, and from 3 to 6 asci. In the American examples the appendages vary from 10 to 35 in number, and are usually about 20, and are from 1 to 2, or even 2½ times the diameter of the perithecium ; in the Japanese example on *Aphananthe* the appendages vary from 7 to 18, and are usually about 12, and equal or slightly exceed the diameter of the perithecium. They are also, as a rule, slightly wider at the base than is usually the case in American *U. Clintonii.*

Both the Japanese specimens agree with *U. Clintonii* in the small subglobose asci, and spores distinctly larger than those of *U. prunastri*, and it seems best therefore, so long as *U. Clintonii* and *U. prunastri* are maintained as distinct species to regard the Japanese plants as belonging to the former species. It may be pointed out that these forms on *Zelkova* and *Aphananthe* differ just as slightly from one another, as either of them does from typical *U. Clintonii.*

11. U. GENICULATA Gerard

U. geniculata Gerard, Bull. Torr. Club, **4**: 48. 1873 ; Sacc. Syll. Fung. **1** : 8. 1882 ; Burr. ; Ell. & Everh. N. Amer. Pyren. 19. 1892.

EXSICC. : Rab.-Wint.-Pazsch. Fung. Eur. 3955 ; *Seym. & Earle, Econ. Fung. 152.

Epiphyllous ; mycelium thin, arachnoid, forming definite patches, or more or less effused, sometimes evanescent ; perithecia subgregarious on the patches, or scattered, small, 90–120 μ in diameter, usually about 100 μ, globose-depressed, cells rather irregular, 10–15 μ wide ; appendages 24–46, 1¼ to twice the diameter of the perithecium, delicate, 3–4 μ wide, some usually abruptly bent or geniculate, simple, colorless, aseptate, thin-walled, smooth or minutely rough at base, apex simply uncinate : asci 5–8, broadly ovate, very shortly stalked, 48–56 × 34–38 μ : spores 4–6, 22 × 12 μ.

Host.—Morus rubra.

Distribution.—NORTH AMERICA : United States—New York (144), Indiana, Alabama, Illinois, Missouri, Kansas.

This species approaches slightly certain forms of *U. salicis*, but is distinct in the smaller perithecia, with fewer delicate narrower appendages, which are not enlarged but usually slightly attenuated upwards. In *U. salicis* the appendages are, as a rule, much

more numerous, and always stouter and wider (5–7 μ wide). Moreover, in most perithecia of *U. geniculata* at least one or two of the appendages show an abrupt geniculate bend, and this character, when present, is quite sufficient to distinguish the present plant from all the species of *Uncinula* except some forms of *U. salicis*, var. *Miyabei*, and from this variety *U. geniculata* differs in the much narrower appendages, not enlarged upwards. Sometimes, however, all the appendages are straight, and *U. geniculata* is then best known by the rather few, delicate, narrow appendages. The asci are described as being 6-spored, but they are frequently 4-spored. The fewer and much longer appendages at once separate the present plant from *U. parvula*.

U. geniculata is confined to the United States ; the record by Issatchenko (171) of its occurrence in Russia rests on an error.

Among the specimens of Erysiphaceae sent to me from the Herbarium of the U. S. Department of Agriculture was one labelled "*Erysiphe cichoracearum* DC. On *Hydrophyllum appendiculatum*. Crawfordsville, Indiana. E. M. Fisher, Oct., 1890. No. 1003." This specimen showed, on examination, only perithecia of a species of *Uncinula* scattered irregularly over the surface of the leaf. Feeling doubtful if this *Uncinula* really originated on this host-plant, I wrote to Professor Galloway on the subject, who replied, "I regret to state that we are unable to give you any information in regard to the care of the material labelled *E. cichoracearum* on *Hydrophyllum appendiculatum*. It has for some years been in mycological envelopes, labelled as above, and whether it was previously in contact with any host bearing *Uncinula*, it is now impossible to ascertain. Nothing but perithecia of *Uncinula* appear to be upon several specimens examined to-day, and we are fearful that the first determination was an error." After a careful comparison of the perithecia, I found them to agree in all characters with those of the present species—*U. geniculata*—which has been recorded only on *Morus rubra*. The leaves of the *Hydrophyllum* show patches of mycelium on the upper surface, and on these as well as on parts of the leaf without mycelium, the perithecia of *U. geniculata* are scattered. These perithecia appear more or less loose, and can be easily lifted off with a needle, and I was not able to observe any connection with the mycelium, nor the occurrence of

any young perithecia. On the whole, it must be left doubtful for the present, for reasons stated in the preface whether *Hydrophyllum appendiculatum* is really a host-plant of *U. geniculata*. I have gone fully into the above case because it affords an exact parallel to that of the single occurrence of *U. salicis* on *Scutellaria lateriflora*.

12. U. POLYCHAETA (Berk. & Curt.) ex. Ellis. [Fig. 89]

Erysiphe polychaeta Berk. & Curt. Grevillea, **4** : 159. 1876.

Uncinula Lynchii Speg. Fung. Argent. Pug. **2** : 17, 44. 1880.

Pleochaeta Curtisii Sacc. & Speg., Sacc. Michelia **2** : 373. 1881 ; Sacc. Syll. Fung. **1** : 9 (partim). 1882 & Addit. ad vols. 1–**4** : 2. 1886.

Uncinula polychaeta (Berk. & Curt.) ex. Ellis in Journ. Myc. **2** : 43. 1886 ; Tr. & Gall. Bot. Gaz. **13** : 29 syn. excl. partim. (cum icon.) 1888 ; Massee, Grevillea, **17** : 78. 1889 ; Sacc. Syll. Fung. **9** : 367. 1891 ; Atkins. Journ. Elisha Mitch. Sci. Soc. **7** : *67. pl. 1. f. 5, 11.* 1891 ; Burr. ; Ell. & Everh. N. Amer. Pyren. 18. 1892.

EXSICC.: Rav. Fung. Carol. Exsicc. fasc. 4, 68 & Ell. & Everh. N. Amer. Fung. 2113, sub *U. polychaeta* Berk. & Curt.; *Seym. & Earle, Econ. Fung. 149 ; *Speg. Dec. Myc. Argent. 39.

Hypophyllous ; mycelium dense, forming irregular whitish patches, or completely evanescent ; perithecia gregarious on the patches of mycelium, or when these are absent, scattered over the surface of the leaf; rounded-lenticular, very large, 215–320 μ in diameter, averaging 255 μ, cells obscure, appendages very numerous, usually about 200, closely crowded, $\frac{1}{4}$–$\frac{2}{3}$ the diameter of the perithecium, smooth, thick-walled with the lumen more or less completely obliterated, simple, colorless, narrowed upwards to the closely uncinate apex, aseptate ; asci very numerous, 34–66, cylindrical or subcylindrical, rarely oblong, more or less abruptly attenuated into an evident stalk, 70–84 × 20–26 μ; spores 2–3, (very rarely 4), 26–30 × 12–14 μ.

Hosts.—*Aphananthe aspera*, *Celtis occidentalis*, *C. tala*, *C. Mississippiensis*, *Celtis* sp. (Chinese).

Distribution.—ASIA : China (Yunnan), Japan.

NORTH AMERICA : United States—South Carolina, Alabama, Mississippi.

SOUTH AMERICA : Argentine (Buenos Ayres).

Very distinct in the large perithecia—the largest in the genus—the closely crowded short appendages, more or less attenuated upwards into the small closely involute apex, and the very numerous 2–3-spored asci.

U. polychaeta has been recorded hitherto only from America, but specimens sent to me as "*Uncinula adunca* Lév. sur *Celtis*, Yunnan, China (leg. Delavay)," by M. Patouillard prove to belong to the present species, and so give an interesting extension to the range of this species hitherto supposed to be endemic to America. Whilst agreeing in all other respects, the Chinese specimens differ in having asci which are regularly 3-spored; in American examples the asci, in my experience, are nearly always 2-spored, with rarely a rudimentary third spore present. Tracy and Galloway (362), however, in their remarks on the American plant, say "spores usually two, oval, subhyaline, nearly filling the ascus. Sometimes three or even four spores are found in an ascus. When three occur in an ascus, two are of nearly the usual size, and the third quite small, and when four occur all are small." It would thus obviously be unsafe to separate in any way the Chinese from the American plant.

Since the above remarks were written Prof. Miyabe has sent me a plant named "*Uncinula* n. sp. related to *U. polychaeta*, but trisporous. On *Aphananthe aspera*, Tokyo, Japan, October 29, 1895 (K. Sengoku)." In this Japanese example most of the asci are 3-spored, although they may be frequently found only 2-spored, and the fungus is evidently to be referred to *U. polychaeta.*

It is necessary to keep the specific name *polychaeta* for the present species. It was described as *Erysiphe polychaeta* Berk. & Curt. and stands first on the same page where *Uncinula polychaeta* Berk. & Curt. was published. The latter species has been renamed *U. confusa* by Massee.

The genus *Pleochaeta* Sacc. and Speg. Michelia **2** : 373. 1881 must be rejected, being founded on young examples of the present species in which the appendages were immature and without the uncinate apex. Ellis (116) and Massee (238) have pointed this out, and Saccardo himself has, in the Sylloge, **9**: 367. 1891 withdrawn the genus. [*Pleochaeta*, however, is still kept up in a subsequent paper by Saccardo (313) published in 1896 and in the

Syll. Fung. **14**: 16. 1899; Lindau also (in Engler and Prantl's Pflanzenfamilien, **1**^{1}: 328, 331. 1897) retains the genus].

13. U. CONFUSA Massee

Uncinula polychaeta Berk. & Curt. Grevillea, **4**: 159. 1876.

Pleochaeta Curtisii Sacc. & Speg.; Sacc. Syll. Fung. **1**: 9 (partim). 1882.

Uncinula confusa Massee, Grevillea, **17**: 78. 1889; Sacc. Syll. Fung. **9**: 367. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 19. 1892.

"Peritheciis sparsis; appendicibus multis. On leaves of *Celtis occidentalis*, Car. No. 5619. Perithecia scattered; appendages about 28, 1½ longer than the diameter of the perithecia, hyaline." (Berk. Grevillea, **4**: 159. 1876).

"Hypophyllous; mycelium very scanty, not forming spots; perithecia scattered, usually not more than two or three on a leaf, 150–200 μ diam., appendages 25–28, simple, colorless, very slender, about 300 × 2–3 μ; apices strongly involute, not at all incrassated; asci about 25, cylindrico-clavate, tetrasporous; spores colorless, simple, elliptic-oblong, 20 × 10 μ" (Massee, Grevillea, **17**: 77. 1889).

Massee's description was based on the result of an examination of the type specimen of "*Uncinula polychaeta*" in the Kew Herbarium. Unfortunately, I have not been able to find on this type-specimen any perithecia which show the characters described by Berkeley and Massee, but, curiously enough, I have found several perithecia of *Uncinula parvula* on the leaf, agreeing perfectly with this species in possessing a diameter of 100–110 μ, 50–70 short, narrow appendages, 5–6 broadly-ovate asci, and 4–7 spores.

The question naturally presents itself, Could this have been the fungus examined by either Berkeley or Massee? I do not think this is possible. In Berkeley's description the rather contradictory characters, "appendicibus multis" and "appendages about 28" appear, but, what is very important, on the type sheet at Kew, Berkeley has given a drawing of a perithecium showing 28 appendages, slightly exceeding the diameter of the perithecium. In the diagnosis, moreover, the appendages are described as "1½ longer than the diameter of the perithecia." In Massee's description the additional characters given, "perithecia 150–200 μ diam.,

asci about 25, cylindrico-clavate" quite prohibit us from supposing that *U. parvula* was under observation.

We seem forced to the conclusion, therefore, that *U. confusa* is a distinct species, one that has apparently disappeared since its original discovery.

U. confusa and *U. polychaeta* were for some time greatly confused with one another. Both species were originally described on page 159 of Grevillea, **4**: 1876; the former appears first on the page as "*Erysiphe polychaeta* Berk. and Curt."; the latter as "*Uncinula polychaeta* Berk. and Curt." The essential characters given for each were these: *E. polychaeta*, appendages many, about equal to the diameter of the perithecium, straight, asci elongated, clavate; *U. polychaeta*, appendages about 28, 1½ longer than the diameter of the perithecium. As a matter of fact, the first species proved to be a true *Uncinula*, and the description "appendages straight" referred only to the immature condition.

"*Erysiphe polychaeta*" has occurred in several places in North America, whilst "*Uncinula polychaeta*" has not been refound since its original discovery. It was not unnatural, therefore, that many botanists meeting with an *Uncinula* on leaves of *Celtis* should refer it to the *Uncinula polychaeta* of Berk. and Curt., rather than to the *Erysiphe polychaeta* of these authors. This was done by Ravenel (Fung. Carol. Exsicc. fasc. **4**: 68) and by Ellis and Everhart in their Exsiccati (N. Amer. Fung. 2113). The same mistake was made by Ellis in the Journal of Mycology, **2**: 52, 53. 1886, where an attempt was made to reconcile the description of the few appendages of *U. polychaeta* Berk. and Curt. with the presence of numerous ones in the plant under observation by saying "The statement in Grevillea that the number of appendages is about 28 is evidently a typographical mistake for 228," and finally by Tracy and Galloway, who gave an excellent figure and description, and who similarly supposed that the description "about 28" was probably a misprint for 280.

Massee (238) first pointed out that "*Erysiphe polychaeta*" was an *Uncinula*, and that this was the species which the authors mentioned above had had under observation, and wrongly identified with the "*Uncinula polychaeta*" of Berk. and Curt. The specific name "*polychaeta*" having to be used, in accordance with

the rules of priority for the *Uncinula*, originally called "*Erysiphe polychaeta*," it became necessary to rename the *Uncinula polychaeta* of Berk. and Curt., which is now known as *Uncinula confusa* Massee.

14. U. AUSTRALIS Speg. [Fig. 61]

Uncinula australis Speg. Fung. Guaran. Pug. **1** : 66, n. 167. 1886; Sacc. Syll. Fung., addit. ad. vols. I.–IV : 1. 1886; and **9** : 366. 1891.

Epiphyllous; mycelium persistent, densely compacted and effused over the surface of the leaf, or thinner and in scattered patches; perithecia scattered, 120–138 μ in diameter, globose-depressed, cells small, about 8 μ wide; appendages numerous, 35–60, 1¼–1½ times the diameter of the perithecium, simple, colorless, aseptate, thin-walled throughout, rough and slightly enlarged in the upper half, but not swollen at the apex, which is simply uncinate; asci about 10, broadly ovate, shortly stalked, $58–65 \times 32–38$ μ; spores 8, rarely 7, $18–20 \times 10–12$ μ.

"Epiphylla; mycelium arachnoideum, grisecenti-album, late folia ambiens, eisque arcte adnatum, tenue, compactiusculum, non pulverulentum; perithecia densiuscule hinc inde sparsa, globoso-depressa, minuta (100–120 diam.) atra, glabra, membranaceo-coriacella, contextu parenchymatico, parum perspicuo, fuligineo, basi 20–40 appendicibus radiantibus ornata; appendices divaricatae ($100–130 \times 4–7$), utrinque gradatim, attenuatae et laeves, medio saepius incrassatulae ac minutissime densiusculeque granuloso-papillosae, apice saepius semel plus minus ve circinatae (rarius rectae atque obtusata), hyalinae. Asci et sporae non visa." (Speg., *loc. cit.*)

Host.—*Eugenia* sp.

Distribution.—SOUTH AMERICA: Paraguay.

The first description given above is drawn up from the specimens in the Kew Herbarium, and in the Herbarium of the Paris Museum, labelled "B. Balansa, Pl. du Paraguay, 1878–1884. Nr. 3814. *Uncinula australis* Speg. Fung. Guaran. pug. **1** : 66. Feuilles d'*Eugenia*. Naranjo, sur la Cordillère de Péribébuy, 24 mai 1883." I have seen no other examples. The original specimens from which Spegazzini drew up his diagnosis, given above, were too young to contain asci, and the description of the appendages as sometimes "straight and obtuse" doubtless refers to the immature condition.

U. australis is apparently distinct from *U. salicis* in the 8-spored asci.

15. U. DELAVAYI Patouill. [Fig. 88]

U. Delavayi Patouill. Journ. de Bot. **2**: 217 (*cum icon.*). 1888; Sacc. Syll. Fung. **9**: 367. 1891.

Hypophyllous; mycelium evanescent; perithecia subgregarious, rounded-lenticular, 98–136 μ in diameter, cells large, 15–20 μ wide, appendages very few, 6–12, usually shorter than the diameter of the perithecium, rarely slightly exceeding it, simple, stout, 7–8 μ wide near the base, hyaline, thin-walled and enlarged at the apex, becoming thick-walled, refractive and sometimes rough towards the base, usually slightly curved throughout their length, colorless, aseptate; asci 4–11, broadly ovate or oblong, very shortly stalked, 58–68 × 34–38 μ; spores 6 or 7, rarely 5, 20–22 × 10–12 μ.

Host.—*Ailanthus* sp.

Distribution.—ASIA: China (Yunnan).

Of a distinct habit in the short, stout, usually curved appendages, not exceeding 12, and usually about 8 in number. *U. Delavayi* is most nearly allied to *U. Sengokui*, which differs in the more numerous, crowded appendages, not or scarcely enlarged upwards.

I am indebted to M. Patouillard for a specimen (now in the Kew Herbarium) from which the above description was drawn up.

M. Patouillard gives (274) a good figure of the present species.

16. U. AUSTRALIANA McAlpine. [Figs. 94, 95]

U. Australiana McAlpine, Journ. Linn. Soc. N. S. Wales, **24**: 302. *pl.* 23. *f.* 5–9. 1899.

Amphigenous; mycelium persistent or subpersistent; perithecia usually gregarious in patches on the mycelium, sometimes more or less scattered, 90–140 μ in diameter, usually about 115 μ, cells 10–15 μ wide; appendages 7–20, usually about 12, about equalling the diameter of the perithecium, rarely 1½ times the diameter, 1-septate and colored pale- or dark-brown at the base (sometimes one here and there aseptate and colorless), simple, smooth, thin-walled, narrowed upwards when young, not enlarged upward when mature, about 5 μ wide in the upper half, apex usually helicoid; asci 3–5, broadly ovate to subglobose, with or without a short stalk, 42–50 × 30–40 μ; spores 5–7, rarely 8, 20–22 × 10–12 μ.

Hosts.—Lagerstroemia Indica, L. ovalifolia.

Distribution.—ASIA: Japan (Sendai, K. Miyabe, Aug., 1893, and Tokyo, S. Hori., 1896).

AUSTRALIA: New South Wales Botanic Gardens, Sydney.

At the beginning of 1899 Professor Miyabe sent me among some Japanese Erysiphaceae an *Uncinula* on *Lagerstroemia Indica*, with the following note; "*U. lagerstroemiae* n. sp. Appendages very characteristic, their tips are circinate very tightly in a helicoid manner; 78–120 × 4.5 μ. Their number is few (3–7).

Subsequently I received from Professor McAlpine an *Uncinula* on *Lagerstroemia ovalifolia* ("sparingly on leaves, but covering entire inflorescence") from the Botanic Gardens, Sydney, under the name of *U. Australiana* McAlp.; with a note that this name would shortly be published.

A comparison of the Japanese and Australian plants showed them to be identical.

U. Australiana is somewhat intermediate between *U. necator* and *U. Sengokui.* The latter species differs in the colorless, more numerous, crowded appendages, distinctly stouter throughout, and 8–9 μ wide in the upper half (where those of *U. Australiana* are only about 6 μ wide); *U. necator* (to the few, short-appendaged forms of which the present species closely approaches) differs in the always more colored appendages. In *U. Australiana* the color is strictly limited to the base, not occurring above the septum; in all forms of *U. necator* the color extends upwards for a considerable distance. In the present species, also, it is not at all uncommon to find some of the appendages of a perithecium quite colorless.*

17. **U. fraxini** Miyabe mss. sp. nov. [Figs. 69–72]

Amphigenous; mycelium evanescent; perithecia scattered, small, 75–105 μ in diameter, usually 80–90 μ, globose-depressed, cells distinct, irregular in shape, averaging 10 μ wide; appendages 10–28, 1½ to 2½ times the diameter of the perithecium, straight or slightly curved, simple, aseptate, thin-walled and hyaline throughout, apex simply uncinate or sometimes distinctly helicoid; asci 4–7, usually 5 or 6, oblong to subglobose, occasionally shortly stalked, 45–58 × 30–40 μ; spores 8, 16–18 × 9–10 μ.

Since the above remarks were written, McAlpine (225) has published an account of his species. It is here stated that the appendages are sometimes forked.

Host.—*Fraxinus longicuspis.*

Distribution.—ASIA: Japan (Sapporo, K. Miyabe, Sept., 1893).

Among the collection of Japanese Erysiphaceae Professor Miyabe sent me specimens of the above plant under the mss. name of *U. fraxini.* As it appears to be a distinct species hitherto undescribed, I have drawn up the above description from the material sent. Professor Miyabe sent the following notes with the specimens: "*U. fraxini* n. sp. Perithecia 82–98 μ; appendages 11–20, 170–225 μ long, slender; asci (6) 30 × 45–49 μ, 8-spored; spores 14–15 × 7–8 μ."

U. fraxini may be known by the evanescent mycelium, hyaline and thin-walled appendages, and the 8-spored asci.

18. **U. Sengokui** sp. nov. [Figs. 64–68]

Amphigenous; mycelium evanescent, or subpersistent, very thin and effused over the upper surface of the leaf; perithecia subgregarious or scattered, 98–135 μ in diameter, cells 10–15 μ wide; appendages more or less crowded, 20–36, equally or (usually) slightly exceeding the diameter of the perithecium, simple, colorless, aseptate, or occasionally 1-septate, stout, 7–8 μ wide in the lower half, not or scarcely enlarged upwards, often curved throughout their length, hyaline above, becoming refractive and thick-walled at the base; asci 7–12, ovate to broadly ovate, usually shortly stalked, 48–58 × 30–34 μ, spores 5–6, 18–20 × 10 μ.

Host.—*Celastrus articulatus.*

Distribution.—ASIA: Japan (Komaba, Tokyo, October, 1895, K. Sengoku).

Among the collection of Erysiphaceae sent to me from Japan by Professor Miyabe, the above species of *Uncinula* appears to be new. Its affinity is undoubtedly with *U. Delavayi*, but the more numerous crowded appendages not or scarcely enlarged upwards easily distinguish the present species.

U. Sengokui, except for the absence of color in the appendages, much resembles certain Japanese forms of *U. necator.*

From all forms of *U. Clintonii*, the present species may be distinguished by the wider base of the appendages.

MICROSPHAERA Lév. Ann. sci. nat. III. **15**: 154, sub *Calocladia*, & 381. 1851

Perithecia globose to globose-depressed: asci several, 2–8-spored. Appendages not interwoven with the mycelium, branched in a definite manner at the apex, which is usually several times dichotomously divided, and often very ornate, rarely (*M. astragali*) undivided or once dichotomous. Etym. *μικρος*, *parvus*, and *σφαιρα*, *sphaera*.

Distribution.—Europe, Asia, and North America; 13 species and 6 varieties.

As a rule, the genus *Microsphaera* is easily known by the much-divided and ornate apex of the appendages. In one species, however, *M. astragali*, the appendages are very frequently unbranched at the apex, and through this species *Microsphaera* approaches the genus *Erysiphe*. From all species of *Erysiphe*, however, *M. astragali* is distinct in the long, white, assurgent, fasciculate appendages. In *E. tortilis*, where the habit is somewhat similar, the appendages are brown. At first sight it seems unnatural to separate in different genera these two species, and some authors have preferred to place *M. astragali* in the genus *Erysiphe*. Apart from the fact, however, that the apex of the appendages in *M. astragali* is sometimes definitely branched in a dichotomous manner (so making the view possible that the unbranched condition is to be considered merely as the result of immaturity), this species is evidently too closely allied to *M. Bäumleri* to be separated generically from it; while *E. tortilis* is similarly very close to certain forms of *E. polygoni*. Magnus (231, p. 150) has lately proposed that the characters of the two genera *Microsphaera* and *Erysiphe* should be emended, but the definitions proposed by this author (which involve the transference of *E. tortilis* to the genus *Microsphaera*) seem to me to be less natural than that which gives the strictly apical branching of *Microsphaera* as the difference of chief generic importance. Magnus (*l. c.*) speaks of angularly bent appendages as being distinctive of the genus *Erysiphe*; this character, as separating the two genera, would, however, break down in *M. euphorbiae* and in many forms of *E. communis*.

I have not seen sufficiently mature examples of *M. umbilici* on *Cotyledon* (*Umbilicus*) *Semenovii* and *M. ferruginea* on *Verbena*

hybrida to be able to indicate the essential specific characters (probably to be found in the shape of the mature apex of the appendages). These two species, therefore, are not included in the key; descriptions, however, of the specimens will be found at the close of the account of the genus.

Key to the Species of Microsphaera*

1. Asci 2-spored, appendages densely crowded, flaccid, about equalling the diameter of the perithecium. 6. *Mougeotii.*
   Asci more than 2-spored. 2.

2. Appendages 2½–7 times the diameter of the perithecium, usually much contorted and angularly bent, apical branching very irregular and lax, with the branches very flexuous and more or less curled. 9. *euphorbiae.*
   Appendages long or short without the above characters. 3.

3. Tips of some or all of the ultimate branches of the appendages recurved. 4.
   Tips not recurved. 11.

4. Appendages 8–12 times the diameter of the perithecium. 10 *Guarinonii.*
   Appendages less than 8 times the diameter of the perithecium. 5.

5. Appendages long and flaccid. 6.
   Appendages short, not exceeding 2½ times the diameter of the perithecium, not flaccid. 8.

6. Apex of appendages much branched, branching ornate, more or less close, spores 22–26 × 12–15 μ. 4. *alni*, var. *extensa.*
   Apex less branched, more or less widely forked, or branching close and simple, spores 18–23 × 9–13 μ. 7.

7. Appendages usually 3½, not exceeding 5½ times the diameter of the perithecium, asci 3–7, ovate-globose, 38–48 μ long. 4. *alni*, var. *divaricata.*
   Appendages 2½–8 times the diameter of the perithecium, asci 2–16, ovate-oblong, 45–72 μ long. 4. *alni*, var. *vaccinii.*

8. Appendages more or less contorted, apical branching very lax and irregular. 4. *alni*, var. *ludens.*
   Appendages not contorted, apical branching closer and regular. 9.

9. Tips of the ultimate branches of the appendages not all regularly and distinctly recurved. 4. *alni*, var. *lonicerae.*
   Tips all regularly and distinctly recurved. 10.

10. Axis of some of the appendages not dividing dichotomously at the apex, but bearing sets of opposite branches (Fig. 16). 4. *alni*, var. *calocladophora.*
    Appendages regularly dichotomous at apex. 4. *alni.*

11. Appendages 3–7 times the diameter of the perithecium, colored nearly to apex. 8. *Russellii.*
    Appendages colorless. 12.

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* *M. umbilici* and *M. ferruginea* are not included in this key (see above).

12. Appendages long and penicillate. 13.
Appendages not penicillate. 15.

13. Apex of appendages often undivided, or irregularly 1–2 times dichotomous. 3. *astragali.*
Apex more divided. 14.

14. Appendages 4–6 times the diameter of the perithecium, branching diffuse and irregular. 13. *Bäumleri.*
Appendages 2½–5½ times the diameter of the perithecium, apex more divided, branching closer. 2. *euonymi.*

15. Branching of the appendages lax, irregular. 16.
Branching closer and regular. 17.

16. Appendages 2–4 times the diameter of the perithecium, not contorted, ultimate branches long, forming a narrow fork. 7. *diffusa.*
Appendages 1–2 times the diameter of the perithecium, more or less contorted, branching more irregular, with short ultimate branches. 4. *alni*, var. *ludens.*

17. Apex of appendages with very short primary and secondary branches more or less digitate (Fig. 34). 5. *grossulariae.*
Apex primary and secondary branches longer. 18.

18. Apex with short, widely spreading, usually curved ultimate branches. 4. *alni*, var. *lonicerae.*
Apex with long, straight ultimate branches, not widely spreading. 1. *berberidis.*

1. M. BERBERIDIS (DC.) Lév. [Figs. 40, 41]

Erysiphe berberidis DC. Fl. Fr. **2**: 275. 1805; Tul. Sel. Fung. Carp. **1**: 204. *pl. 5. f. 1.* 1861; de Bary, Beitr. Morph. Phys. Pilz. **1**: § xiii. 51. 1870.

Alphitomorpha penicillata, var. *berberidis* Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 40. 1819; Wallr. Fl. Crypt. Germ. **2**: 754. 1833.

Erysibe berberidis DC.; Gray, Nat. Arr. Brit. Pl. **1**: 590. 1821.

E. divaricata β Schlecht. Fl. Berol. **2**: 169. 1824.

E. penicillata, var. *berberidis* Lk.; Willd. Sp. Pl. **6**: 114. 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 236. 1844.

Erysiphe penicillata, var. *berberidis* Fr. Syst. Myc. **3**: 244. 1829; Duby, Bot. Gall. **2**: 871. 1830.

E. penicillata Lk.; Johnst. Fl. Berw. **2**: 143. 1831; Berk.; Sm. Engl. Fl. **5**: 327 (partim). 1836.

Erysibe divaricata Rabenh. Fl. Lusat. **2**: 420 (partim). 1840.

Microsphaera berberidis Lév. Ann. sci. nat. III. **15**: 159. *pl. 10. f. 28* (sub *Calocladia*). 1851; Cooke, Micr. Fung. 219. *pl.*

11. f. 229–232. 1865; Cooke, Handb. Brit. Fung. **2**: 649. 1871; Sacc. Syll. Fung. **1**: 13. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 36. 1884; Karst. Act. Soc. Faun. Flor. Fenn. **2**: 91. 1885; Schroet.; Cohn's Krypt. Fl. Schles. **3**: 243. 1893; Jacz. Bull. l'Herb. Boiss. **4**: 746. 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 92. 1897.

Calocladia berberidis Lév. Dietr. Blick. Crypt. Ostseeprov. 336. 1856; Karst. Myc. Fenn. **2**: 196. 1873.

Podosphaera berberidis Lév.; Quél. Champ. Jur. Vosg. **3**: 106. 1875.

Exsicc.: Rab.-Wint.-Patzsch. Fung. Eur. 3855; Rab. Fung. Eur. 555, 2318; Rehm. Ascom. 499; Fckl. Fung. Rhen. 693; de Thüm. Fung. austr. 137; Syd. Myc. March. 246; Roumeg. Fung. Select. Gall. Exsicc. 159; Oudem. Fung. Neerl. Exsicc. 153; Rab. Herb. Myc. ed. 2, 459; Cooke, Fung. Brit. Exsicc. 95, ed. sec. 283; de Thüm. Myc. univ. 1838; Kunze. Fung. select. exsicc. 320; Westend. Herb. Crypt. Belg. 738; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 519; Vize. Fung. Brit. 93; *Erikss. Fung. par. scand. 143.

Amphigenous; mycelium evanescent, or sometimes sub-persistent in irregular patches, or very thinly effused over the whole surface of the leaf; perithecia usually scattered, occasionally more or less densely gregarious, 90–125 μ in diameter, cells 10–15 μ wide; appendages 5–20, 1¼–2½ times the diameter of the perithecium, colorless, thin-walled above, becoming thick-walled in the lower half when mature, aseptate, smooth, apex regularly 4 times dichotomously branched, branching rather close, branches of the last order more or less parallel, never widely spreading, tips of ultimate branches not recurved; asci 4–9, ovate-oblong, very shortly stalked, $48–56 \times 26–32\ \mu$; spores 3–6, usually 4, $18–22 \times 9–11\ \mu$.

Host.—*B. aquifolium*, *B. vulgaris.*

Distribution.—Europe: Britain, France, Belgium, Netherlands, Germany, Switzerland, Italy (307), Austria-Hungary, Servia (318), Norway, Sweden, Finland (192), Russia.

Asia:—Cyprus, Transcaucasia (338), Turkestan, Japan.

Somewhat intermediate between *M. grossulariae* and *M. alni*, var. *lonicerae.* The apex of the appendages is regularly 4 times divided, and the straight ultimate branches do not spread widely, but lie more or less parallel to one another, in this respect some-

what recalling those of *M. grossulariae*. In *M. berberidis*, however, the branches of the first and second orders are of about equal length to the others, so that the manner of branching of the whole apex differs conspicuously from that of *M. grossulariae*, where the primary and secondary branches are extremely short (*cf.* Figs. 34, 35, and 40, 41). *M. grossulariae* has, also, shorter appendages and slightly larger spores.

M. alni, var. *lonicerae* differs from *M. berberidis* in the spreading ultimate branches of the apex of the appendages, which occasionally have recurved tips, the usually fewer asci, etc.

At the beginning of last November my attention was directed to some bushes of *Berberis* (*Mahonia*) *aquifolium* in a shrubbery near Reigate, Surrey, England, which were, chiefly on the young shoots, more or less white with the mycelium of *M. berberidis*. The perithecia were densely gregarious on both sides of the leaf, and agreed in all characters with examples of the species on the usual host, *B. vulgaris*. This occurrence on an evergreen species of *Berberis* is very interesting, as hitherto in its wide range in Europe, and in Asia, the species has been supposed to be absolutely confined to a single species or host-plant, viz. *Berberis vulgaris*.

The Japanese example of the present species was sent to me by Prof. Miyabe, and agrees perfectly with the European plant, and the same is the case with beautiful specimens sent by Prof. Gennardius from Cyprus.

2. M. EUONYMI (DC.) Sacc.

Erysiphe euonymi DC. Fl. Fr. **6**: 105. 1815; Duby, Bot. Gall. **2**: 871. 1830.

Alphitomorpha comata Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 40. 1819; Wallr. Fl. Crypt. Germ. **2**: 757. 1833.

A. euonymi Wallr. Ann. Well. Ges. **4**: 245. 1819.

Erysibe comata (Wallr.) Ficin. Schub. Fl. Gegend. Dresd. **2**: xix. 1823; Lk. in Willd. Sp. Pl. **6**: 114. 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 231. 1844.

Erysiphe penicillata, var. *euonymi* Fr. Syst. Myc. **3**: 244. 1829.

E. comata Lk.; Secret. Mycogr. Suisse, **3**: 653. 1833.

Microsphaera comata Lév. Ann. Sci. Nat. III. **15**: 157. *pl. 9.*

f. 23 (sub *Calocladia*). 1851 ; Cooke, Handb. Brit. Fung. **2** : 649. 1871.

Calocladia comata Lév. ; Dietr. Blick. Crypt. Ostseeprov. 336. 1856.

Podosphaera comata (Lév.) Quél. Cham. Jur. Vosg. **3** : 106. 1875.

Microsphaera euonymi (DC.) Sacc. Syll. Fung. **1** : 11. 1882 ; Wint. ; Rabenh. Krypt. Fl. Deutschl. $\mathbf{1}^2$: 37. 1884 ; Schroet. ; Cohn's Krypt. Fl. Schles. **3** : 242. 1893 ; Jacz. Bull. l'Herb. Boiss. **4** : 749. 1896 ; Oudem. Rév. Champ. Pays.-Bas. **2** : 90. 1897.

EXSICC.: de Thuem. Fung. austr. 1238 ; Sacc. Myc. Ven. 892 ; Syd. Myc. March. 199, *4335, *4336 ; Fckl. Fung. Rhen. 692 ; Cooke, Fung. Brit. Exsicc. 94 ; Rab. Fung. Eur. 438, 1324, 2319; Rehm. Ascom. 248 ; Roumeg. Fung. Gall. exsicc. 3224 ; Vize. Fung. Brit. 196 ; *de Thuem. Myc. univ. 847 ; *Kneiff. & Hart. Pl. Crypt. Bad. 55 ; Wint. Fung. Helvet. Supp. 84 (in Herb. Earle).

Usually hypophyllous, very rarely amphigenous ; mycelium evanescent or nearly so ; perithecia more or less densely gregarious, 85–138 μ in diameter, cells obscure, about 10 μ wide ; appendages 6–14, 2½–5½ times the diameter of the perithecium, flaccid, colorless, thin-walled above, becoming thick-walled towards the base, aseptate, smooth, fasciculate and forming a flaccid "pencil" which lies on the surface of the leaf, apex variously 3–5 times dichotomously, or sub-dichotomously, branched, branching variable, lax or close, tips of ultimate branches usually straight ; asci 3–7, ovate to broadly ovate, 50–60 × 30–38 μ, with a short stalk ; spores 3–5, 20–23 × 10–12 μ.

Hosts.—*Euonymus Europaeus*, *E. verrucosus* (294).

Distribution.—EUROPE : Britain, France, Belgium (47) (209), Netherlands (263), Germany, Switzerland, Italy, Austria-Hungary, Denmark, Finland, Russia.

A well-characterized species in the fasciculate habit of the long appendages (which form when mature a flaccid "pencil"), and the much-branched apex.

In other characters *M. euonymi* is very variable, especially as regards the manner of branching of the apex of the appendages. The branching is sometimes somewhat lax, and the apex is 3 times dichotomously divided, with the primary and secondary branches more or less recurved, often strongly so, and even the

tips of the ultimate branches show, in this form, a slight tendency to become recurved; the specimen in de Thüm. Fung. austr. 1238 illustrates this form. More frequently, however, the apex is closely 4–5 times branched, when the dichotomous arrangement often ceases at the branches of the third order, and the subsequent branches are irregularly arranged, short, often very flexuous and lying in different planes, with the tips not at all recurved, *e. g.*, the specimen in Rabenh. Fung. Eur. 1324. In other specimens, again, the branching is dense, the primary branches short, and the subsequent ones long, straight and narrow.

M. euonymi is confined to Europe; the record of its occurrence in California "on *Euonymus*" by Harkness and Moore (159) is doubtless an error.

3. M. ASTRAGALI (DC.) Trev. [Figs. 47–51]

Erysiphe astragali DC. Fl. Fr. **6**: 105. 1815; Duby, Bot. Gall. **2**: 871. 1830; Tul. Sel. Fung. Carp **1**: 206. *pl. 2. f. 4.* 1861; de Bary, Beitr. Morph. Phys. Pilz. **1**: § xiii. 51. 1870.

Alphitomorpha holosericea Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 41. 1819.

A. astragali Wallr. Ann. Wett. Ges. **4**: 244. 1819.

Erysibe holosericea (*astragali*) Lk.; Willd. Sp. Pl. **6**: 115. 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 231. 1844.

Erysiphe communis, & *E. holosericea* Fr. Syst. Myc. **3**: 240. 1829.

Alphitomorpha sericea Wallr. Fl. Crypt. Germ. **2**: 757. 1833.

Microsphaera holosericea Lév. Ann. Sci. Nat. III. **15**: 159. *pl. 9. f. 27* (sub *Calocladia*). 1851.

M. astragali (DC.) Trev., Spighe e Paglie, **1**: 39. 1853 (fide Sacc.); Sacc. Syll. Fung. **1**: 12. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 35. 1884; Jacz. Bull. l'Herb. Boiss. **4**: 746. 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 91. 1897.

Calocladia holosericea Lév. Dietr. Blick. Crypt. Ostseeprov. 336. 1856; Fckl. Symb. Myc. 82. 1869–70.

Erysibe astragali Schroet.; Cohn's Krypt. Fl. Schles. **3**: 241. 1893.

EXSICC.: Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 924,*ed. 2, ser. 1, 224; Rab. Fung. Eur. 439, 2413; Westend. Herb. Crypt. Belg. 1059;

Roumeg. Fung. Gall. Exsicc. 1164, 3141; de Thüm. Fung. austr. 459; Fckl. Fung. Rhen. 694; Sacc. Myc. Ven. 148; Rab. Herb. myc. ed. 2, 469; Oudem. Fung. Neerl. Exsicc. 159; Erb. Critt. Ital. 144, *193; Rehm. Ascom. 448; * Syd. Myc. March. 979; * Romell. Fung. exsicc. praes. scand. 62.

Hypophyllous, or amphigenous; mycelium evanescent, or sometimes faintly persistent; perithecia usually densely gregarious, but sometimes scattered, globose-depressed, 95–146 μ in diameter, cells small, about 10 μ wide, appendages 5–18, 4–10 times the diameter of the perithecium, smooth, colorless and aseptate (sometimes brown towards the base, and then usually septate), hyaline above, becoming thick-walled and refractive in the lower half when mature, flexuous, sub-flaccid, penicillate, apex frequently unbranched (? immature) or once or twice dichotomously branched, branching lax and vague, primary branches usually long, and more or less recurved, tips of ultimate branches not recurved; asci 5–12, ovate-oblong to broadly-ovate, 52–68 × 30–38 μ, usually stalked; spores 3–6, usually 4, 20–23 × 10–12 μ.

Hosts.—*Astragalus Cicer* (164*) (384), *A. Glycyphyllos*, *A. onobrychis* (390).

Distribution.—Europe: Britain, France, Belgium, Netherlands, Germany, Switzerland, Italy, Austria-Hungary, Denmark, Norway, Sweden, Russia.

M. astragali is related *M. Bäumleri* and *M. euonymi* in the flaccid penicillate appendages, but differs from both species in the apex of the appendages being less branched. In the present species the very long and flexuous appendages, which are about 6 μ wide, are thick-walled and shining in their lower half, and whether seen singly under the microscope or in dense clusters on the leaf, present a shining silky appearance which makes the old specific name of *holosericea* very appropriate. The apical branching of the appendages is extremely ill-defined, in fact, there are usually only two or three appendages in any perithecium which show any signs of branching at all. I have once seen the apex feebly 3-times dichotomous, rarely it is twice dichotomous, but is usually (when branched at all) only once forked, as is generally described.

Several authors, on account of this slight branching of the appendages, have placed the present species in *Erysiphe;* the apical branching, however, when present, is regularly dichotomous and

definite, and unlike that found in *Erysiphe*, and the proper position of the present plant is certainly in *Microsphaera*, to one species of which—*M. Bäumleri*—it shows a close relationship.

M. astragali is confined to Europe; the plants referred to this species from North America all belong (as far as I have seen) to *M. euphorbiae*. This is the case with the specimen "*M. holosericea* Lév., on leaves of *Astragalus Cooperi*, Buffalo, N. Y. (C. H. Peck, n. 198)," recorded by Cooke and Peck in the Journal of Botany (91), and mentioned in Saccardo's Sylloge, **1**: 12; also with the specimen named "*M. holosericea*" on an unnamed host-plant (probably *Astragalus Drummondii*), n. 1572, Flora of Colorado, Colorado Springs (5500 ft.), 1879 (M. E. Jones); and with other examples.

Massalongo (237, p. 127) has recorded "*M. astragali β cytisi*" on "*Cytisus alpinus* (vel *C. Laburnum*)." Specimens (now in the Kew Herbarium) kindly sent to me by this author prove to belong to *M. Guarinonii*.

Winter records *M. astragali* on *Astragalus virgatus*, but the fungus so-named on this host in the Exsiccati quoted by this author (de Thuem. Fung. austr. 1237) is *Erysiphe polygoni*.

4. M. ALNI (Wallr.). [Figs. 1–14]

Alphitomorpha penicillata, var. *alni* Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 40 (syn. excl.). 1819.

A. alni Wallr. Ann. Wett. Ges. **4**: 237 (syn. excl.). 1819.

A. penicillata, var. *rhamni cathartici* Schlecht. Berl. Ges. Nat. Freund. Verh. **1**: 49. 1819.

Erysibe penicillata Lk.; Willd. Sp. Pl. **6**: 113 (excl. vars. *grossulariae* and *berberidis*, and syn. *E. alni* DC.). 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 236 (partim). 1844.

Erysiphe penicillata Fr. Syst. Myc. **3**: 244 (partim). 1829; Duby, Bot. Gall. **2**: 871 (partim). 1830; Berk.; Sm. Engl. Fl. **5**: 327 (partim). 1836.

E. viburni Duby, Bot. Gall. **2**: 872. 1830.

Alphitomorpha penicillata Wallr. Fl. Crypt. Germ. **2**: 754 (partim). 1833.

Erysiphe densissima Schwein. Syn. Fung. Am. Bor. 269. 1834.

E. ceanothi Schwein. Syn. Fung. Am. Bor. 269. 1834; Sacc. Syll. Fung. **1**: 22. 1882.

E. viburni Schwein. Syn. Fung. Am. Bor. 269. 1834; Sacc. Syll. Fung. **1**: 21. 1882.

E. syringae Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1**: 21. 1882.

E. quercinum Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1**: 22. 1882.

Microsphaera Hedwigii Lév. Ann. sci. nat. III. **15**: 155. *pl. 8. f. 19* (sub *Calocladia*). 1851; Cooke, Mícr. Fung. 219. 1865; Cooke, Handb. Brit. Fung. **2**: 648. *f. 316.* 1871; Sacc. Syll. Fung. **1**: 11. 1882; Oudem. Rév. Champ. Pays.-Bas. **2**: 90. 1897.

M. penicillata Lév. Ann. sci. nat. III. **15**: 153. *pl. 8. f. 21* (sub *Calocladia*) (excl. syn. *E. alni* DC. & *Sclerot. Erysiphe*, var. *alnea* Schleich). 1851; Cooke, Micr. Fung. 219. *pl. 11. f. 234.* 1865; Cooke, Handb. Brit. Fung. **2**: 649. 1871; Sacc. Syll. Fung. **1**: 13. 1882; Oudem. Rév. Champ. Pays.-Bas. **2**: 92 (excl. syn. *E. alni* DC.). 1897.

M. Friesii Lév. Ann. sci. nat. III. **15**: 156. *pl. 8. f. 20* (sub *Calocladia*) (éxcl. syn.). 1851; Sacc. Syll. Fung. **1**: 13. 1882.

Calocladia Friesii Lév. Dietr. Blick. Crypt. Ostseeprov. 337. 1856.

Erysiphe alni Tul. Sel. Fung. Carp. **1**: 203. *pl. 2. f. 5–7* (excl. syn. *E. alni* DC.). 1861.

Calocladia Hedwigii Lév. Fckl. Symb. Myc. 81. 1869–70.

C. penicillata Lév.; Fckl. Symb. Myc. 81. 1869–70; Karst. Myc. Fenn. **2**: 196. 1873.

Microsphaera pulchra Cooke & Peck, Journ. of Bot. II. **1**: 12. 1872; Peck, Reg. Rep. **25**: 95. 1873; Sacc. Syll. Fung. **1**: 12. 1882.

M. Friesii, var. *syringae* Cooke & Peck, Journ. of Bot. II. **1**: 12. 1872.

M. Friesii, var. *vaccinii* Cooke & Peck, Journ. of Bot. II. **1**: 12. 1872.

M. semitosta Berk. & Curt. ex Cooke & Peck, Journ. of Bot. II. **1**: 13. 1872; Berk. & Curt. Grevillea, **4**: 160. 1876; Sacc. Syll. Fung. **1**: 11. 1882; Burr. & Earle, Bull. Ill. State Lab. Nat.

Hist. **2** : 415. 1887 ; Atkins. Journ. Elisha Mitch. Sci. Soc. **7** : 69. *pl. 1. f. 12–14.* 1891 ; Burr. ; Ell. & Everh. N. Amer. Pyren. 25. 1892.

M. sparsa E. C. Howe ; Cooke & Peck, Journ. of Bot. II. **1** : 171. 1872.

M. penicillata, var. *alni* Cooke & Peck, Journ. of Bot. II. **1** : 171. 1872.

M. densissima (Schwein.) Cooke & Peck, Journ. of Bot. II. **1** : 171. 1872 ; Peck, Reg. Rep. **26** : 80. 1874 ; Sacc. Syll. Fung. **1** : 15. 1882.

M. menispermi E. C. Howe, Bull. Torr. Club, **5** : 3. 1874 ; Sacc. Syll. Fung. **9** : 369. 1891 ; Burr. ; Ell. & Everh. N. Amer. Pyren. 22. 1892.

M. platani E. C. Howe, Bull. Torr. Club, **5** : 4. 1874 ; Sacc. Syll. Fung. **9** : 369. 1891.

M. viburni E. C. Howe, Bull. Torr. Club, **5** : 43. 1874 ; Sacc. Syll. Fung. **9** : 369. 1891.

Podosphaera Hedwigii (Lév.) Quél. Champ. Jur. Vosg. **3** : 106. 1875.

P. penicillata (Lév.) Quél. Champ. Jur. Vosg. **3** : 106. 1875.

Microsphaera abbreviata Peck, Reg. Rep. **28** : 64. *pl. 2. f. 4, 5.* 1876 ; Sacc. Syll. Fung. **1** : 11. 1882.

M. Ravenelii Berk. Grevillea, **4** : 160. 1876 ; Sacc. Syll. Fung. **1** : 14. 1882 ; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2** : 420. *f. 8.* 1887 ; Burr. ; Ell. & Everh. N. Amer. Pyren. 23. 1892.

M. erineophila Peck, Bull. Torr. Club, **10** : 75. 1883 ; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2** : 419. 1887 ; Sacc. Syll. Fung. Addit. ad Vols. I.–IV.: 2. 1886 ; and **9** : 368. 1891 ; Burr. ; Ell. & Everh. N. Amer. Pyren. 29. 1892.

M. alni (DC.) Wint. ; Rabenh. Krypt. Fl. Deutschl. $\mathbf{1}^2$: 38. 1884 ; Karst. Act. Soc. Faun. Fl. Fenn. **2** : 92 (excl. syn. *E. alni* DC.). 1885 ; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2** : 421 (excl. syn. *E. alni* and *M. Van Bruntiana* E. C. Howe). 1887 ; Atkins. Journ. Elisha Mitch. Sci. Soc. **7** : 71. 1891 ; Burr. ; Ell. & Everh. N. Amer. Pyren. 27 (excl. syn. *E. alni* DC. and *E. betulae* DC.). 1892 ; Schroet. ; Cohn's Krypt. Fl. Schles. **3** : 244. 1893 ; Jacz. Bull. l'Herb. Boiss. **4** : 748 (excl. syn. *E. alni*). 1896.

M. nemopanthis Peck, Reg. Rep. **38**: 102. 1886; Sacc. Syll. Fung. Addit. ad Vols. I.–IV.: 2. 1886; and **9**: 368. 1891.

M. quercina (Schwein.) Burr.; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 424 (partim). 1887; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 72. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 28 (partim). 1892.

M. quercina, var. *abbreviata* Atkins. Journ. Elisha Mitch. Sci. **7**: 73. 1891.

Exsicc.: Syd. Myc. March. *247, 657, 2662, *3672, *3720, *3721, *3947, *4334, *4433; Fckl. Fung. Rhen. 690, 691, 695; Lib. Pl. Crypt. Ard. fasc. 1, 81; Rab. Fung. Eur. 437, 2031, *2032; Sacc. Myc. Ven. 147, 618, 619, 893; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 921, 922 (A. & B.), 923, *ed. 2, ser. 1, 221, 222, 223; de Thüm. Fung. austr. 138, 139; Baxt. Stirp. Crypt. Oxon.; Rehm. Ascom. 299, 446, 599, 848; Bri. & Cav. Fung. par. 40; Cooke Fung. Brit. exsicc. 218; de Thuem. Myc. univ. 56, 155, 557, 558, 958, 2054, 2055; Westend. Herb. Crypt. Belg. 112; and 831 (in Herb. Jard. bot. Bruxelles); Kunze. Fung. select. exsicc. 237, 318, 576; Rab. Herb. Myc. ed. 2, 474; and 462 sub *Erysibe guttata*, var. *betulae;* Ell. N. Amer. Fung. 428, 432, 659, 767, 770, 1325; Ell. & Everh. N. Amer. Fung. 660, 1539, 1945; and 559 sub *M. Dubyi;* sec. ser. 1783, 3008; Rab.-Wint.-Pazsch. Fung. Eur. 3953; Rav. Fung. Amer. Exsicc. 87, 626, 627; Rav. Fung. Car. Exsicc. 67, 68; Vize. Fung. Brit. 198, 473; Roumeg. Fung. Gall. Exsicc. 3650; Rab.-Wint. Fung. Eur. 3044, 3245, 3744; Roumeg. Fung. select. exsicc. 4563; *Ell. & Everh. Fung. Columb. 111, 508; *Wartm. & Wint. Schweiz. Crypt. 825; *Wartm. & Schenk, Schweiz. Krypt. 424; *Seym. & Earle, Econ. Fung. 45, 124, 176, 183, 187; Wint. Fung. Helvet. Supp. 85 (in Herb. Earle); Klotzsch. Herb. Myc. 178 (in Herb. Upsala Mus.); Schleich. cent. exsicc. 68 (in Herb. De Candolle).

Amphigenous; mycelium evanescent, or persistent, and then thin and usually more or less effused over the surface of the leaf, or rarely (as sometimes on *Quercus*, *Alnus*, *Viburnum* and *Vaccinium*) forming definite, more or less rounded patches; perithecia scattered or more or less densely gregarious, globose depressed, very variable in size, usually small, 66–110 μ in diameter,

sometimes 110–135 μ, cells 10–15 μ wide, rarely 15–18 μ; appendages very variable in number and length, 4–26, ⅓–2½ times the diameter of the perithecium, usually about 1½ times diameter, more or less rigid, colorless throughout or amber-brown at base, or rarely colored to the commencement of the apical branching, smooth, or occasionally rough toward the base, which usually becomes thick-walled, aseptate or occasionally 1–2-septate toward the base, apex variously but always more or less closely, 3–6 times dichotomously branched, tips of ultimate branches regularly and distinctly recurved; asci 3–8, ovate to ovate globose, 42–70 × 32–50 μ, usually but not always shortly stalked; spores 4–8, 18–23 × 10–12 μ.

Hosts.—*Alnus glutinosa*, *A. incana* and var. *virescens*, *A. maritima*, *A. rubra*, *A. serrulata*, *A. viridis*, *Apios tuberosa*, *Astragalus adsurgens* (60), *Betula alba*, *B. lenta*, *B. lutea*, *B. pumila* (60) (97), *Carpinus Americana* (60), *Carya alba*, *C. sulcata*, *Castanea dentata* (249), *C. sativa* and vars. *Americana* and *Japonica*, *Ceanothus Americanus*, *Celastrus scandens* (60), *Cephalanthus occidentalis*, *Cornus alternifolia*, *C. Amonum* (60), *C. macrophylla*, *C. stolonifera* (363), *Corylus Americana*, *C. rostrata* and var. *Mandshurica*, *Euonymus atropurpureus*, *Fagus atropunicea* (249), *F. ferruginea*, *Forestiera acuminata*, *Gleditschia triacanthos*, *Gymnocladus* sp., *Ilex decidua*, *I. mollis* (371), *I. verticillata* (97), *Juglans cinerea*, *J. nigra*, *Lathyrus ochroleucus*, *L. palustris* (61), *L. pratensis*, *L. venosus*, *Ligustrum medium*, *Lonicera flava*, *L. glauca*, *L. glaucescens*, *L. hirsuta* (60), *L. involucrata*, *L. oblongifolia*, *L. parviflora*, *L. sempervirens*, *L. Sullivantii* (60), *Lyonia paniculata* (60), *Menispermum Canadense*, *Nemopanthus fascicularis*, *Ostrya Virginica*, *Picrasma quassioides*, *Platanus occidentalis*, *Quercus alba*, *Q. aquatica*, *Q. bicolor*, *Q. bicolor* × *macrocarpa*, *Q. bicolor* × *Michauxii*, *Q. Catesbaei*, *Q. coccinea* and var. *tinctoria*, *Q. crispula*, *Q. dentata*, *Q. falcata*, *Q. imbricaria*, *Q. lyrata*, *Q. macrocarpa*, *Q. nigra*, *Q. obtusiloba*, *Q. Phellos*, *Q. Prinus*, *Q. Robur*, *Q. rubra*, *Rhamnus cathartica*, *Rhododendron nudiflorum*, *Sambucus Canadensis* (122), (265), *Schizandra Chinensis*, *Syringa Amurensis*, var. *Japonica*, *S. Persica* (269), *S. vulgaris*, *Tecoma radicans*, *Ulmus Americana*, *Vaccinium corymbosum*, *Viburnum acerifolium*, *V. dentatum*, *V. Lantana*, *V. Lentago*, *V. Opulus*, *V. prunifolium*, *V. pubescens*, *V. Tinus* (246), *Vicia Americana* and var. *linearis*, *Zelkova acuminata* [*Populus grandidentata*].

Distribution.—EUROPE: Britain, France, Belgium, Netherlands, Germany, Switzerland, Italy, Austria-Hungary, Denmark, Norway, Sweden, Russia.

ASIA: Transcaucasia (338), Japan.

NORTH AMERICA: United States—Maine, Vermont (153), Massachusetts, Connecticut, New York, Pennsylvania, Maryland, New Jersey, Delaware, West Virginia, North and South Carolina, Ohio, Michigan, Indiana, Alabama, Illinois, Mississippi, Wisconsin, Missouri, Iowa, Minnesota, South Dakota, Kansas, Montana, Wyoming, Colorado, California (159), Washington. Canada, New Brunswick, Ontario, Manitoba.

The most variable species of the Erysiphaceae. Starting with the forms described as *M. Hedwigii*, *M. Friesii* and *M. penicillata* by Léveillé, examination of authentic specimens in the Kew Herbarium shows conclusively that these represent but a single species. The specific character on which Léveillé relied for the separation of *Hedwigii*, *Friesii* and *penicillata* was the presence of respectively 4, 6 and 8 spores in the ascus. Dealing only with the authentic specimens from Léveillé's Herbarium, we find up to 7 spores in specimens named *Hedwigii*, 4–7 spores in *Friesii*, and 4–8 spores in *penicillata*. It is quite clear, therefore, that the species under consideration must be allowed a range of 4–8 spores. We may note, too, that in these same specimens, the perithecia vary in diameter from 68–110 μ.

Winter (394) has already pointed out that these three species of Léveillé's must be united, and has adopted as the oldest name for the plant *Erysiphe alni* DC., calling the present species, therefore, *M. alni* (DC.) Wint. Unfortunately, this identification is incorrect, as De Candolle's *E. alni* is really the species now known as *Phyllactinia corylea*. De Candolle described his species as follows (Syn. Pl. Fl. Gall. p. 57): "Hypophylla, filamentis plurimis expansis longissimis liberis," and added as a synonym "*Sclerotium Erysiphe alnea* Schl. cent. exs. nr. 68." De Candolle added in Lam. Enc. Méth. (Bot.) 8: 219, these remarks, "Il y a beaucoup de rapport entre cette espèce et la précédente [*Erysiphe coryli* Hedw. = *Phyllactinia corylea*]; elle en diffère par les filaments de sa base, beaucoup plus longs, plus étalés et en plus grand nombre." This description leaves no doubt that examples of *Phyllactinia*

corylea on *Alnus* were under observation. M. Casimir de Candolle has kindly sent me the example of "Schleich. cent. exsicc. n. 68" from De Candolle's herbarium, and the fungus proves to be *Phyllactinia corylea.*

Wallroth was apparently the first to confuse the present species of *Microsphaera* with De Candolle's plant, as this author gives to his *Alphitomorpha penicillata*, var. *alni*, which from the description we recognize as a *Microsphaera*; the synonym *Erysiphe alni* DC. Fortunately, therefore, we can still, by adopting Wallroth's varietal name, retain the specific name *alni* for the present species.

Returning to the study of the various forms of *M. alni* (Wallr.) we find that in American examples the perithecia, which are sometimes (*e. g.*, in certain specimens on *Corylus Americana*) only 66 μ in diameter may reach to as much as 130 μ in diameter on other hosts. In American material, further, the appendages gradually become longer, reaching in rare cases a length of 2½ times the diameter of the perithecium. Also, the branching of the apex of the appendages tends gradually to become more elaborate, reaching its height in the forms on *Cornus* and *Quercus* which have been described as *M. pulchra*, *M. densissima*, and *M. quercina.*

M. pulchra has already been united by American mycologists to *M. alni*, and there can be no doubt of the correctness of this arrangement. This plant on *Cornus alternifolia* is nevertheless one of the most striking of the American forms, and in its extreme state, with the perithecia 130 μ in diameter, with 17–22 appendages 1½ to twice the diameter, and especially the very ornate apical branching, producing a more or less square outline (Figs. 4–6) seems at first almost worthy of separation. There is, however, no difficulty with sufficient material at hand, in seeing that "*M. pulchra*" is too intimately connected with many American forms of *M. alni.* I have seen specimens on *Alnus incana* from New York with perithecia averaging 120 μ in diameter, with 20–26 appendages, not much exceeding the diameter of the perithecium, but with the apical branching very similar to that of "*M. pulchra.*" Moreover, the large sized perithecia and numerous appendages are not invariably found in "*M. pulchra*" itself; in the type specimen there occur side by side with perithecia 130 μ in diameter, with 16–20 appendages, smaller ones (containing ripe asci) 90 μ in diameter, with only 6 appendages.

M. quercina (Schwein.) Burr. is maintained as a species by Burrill in Ellis and Everhart's N. Amer. Pyrenomycetes. This species on American oaks has been built up out of *Erysiphe quercina* Schwein., *Microsphaera extensa* Cooke and Peck, and *M. abbreviata* Peck.

M. abbreviata Peck, occurring on certain oaks, was described (279) as "allied to *M. Hedwigii* [= *M. alni*], from which it is separated because of the short scabrous appendages." These characters prove wholly insufficient to distinguish this form, and "*M. abbreviata*" may safely be considered a synonym of *M. alni*.

M. extensa Cooke and Peck, however, is a marked plant in its typical form with the long flaccid appendages, and although connected by intermediates with *M. alni*, I consider it is worthy of being separated as a variety.

M. quercina (Schwein.) Burr. has always been recognized as a somewhat unsatisfactory species. Burrill, *e. g.*, says (60, p. 29), "It must be acknowledged that it is well nigh impossible to distinguish some forms referred to *M. alni* from certain specimens placed under *M. quercina*, except by reference to the host-plants." By separating *M. extensa* as a variety, and uniting the other forms on oaks with *M. alni*, from which they do not differ except in occasionally showing a slightly more elaborately branched apex, we get a more natural arrangement of the American forms of *Microsphaera* on *Quercus*.

M. densissima (Schwein.) Cooke and Peck (91) must certainly be referred to *M. alni*. The plant is thus described: "Hyphasma very dense, between filamentose and himantioid, indefinite suborbicular patches ½–2 in. broad, somewhat radiating at the margin, persistent; concepticles few, scattered; appendages 6–10, sporangia 4–8; sporidia 8. Remarkable for the definite orbicular patches of mycelium. On leaves of *Quercus*." In Cooke and Peck's type the persistent mycelium forms definite suborbicular spots on which the perithecia are seated; in all other respects the characters shown are those of ordinary *M. alni*. Curiously in the specimen of "*Erysiphe densissima*" from Schweinitz's herbarium, in Berkeley's herbarium at Kew (which is identical in other respects with Cooke and Peck's specimen, and is accepted as the same species by Cooke), the mycelium is completely evanescent. It is quite

certain that in *M. alni*, as in many species of the Erysiphaceae, the mycelial characters are too variable to be of any systematic value. In an interesting series of specimens in the Kew Herbarium, from the herbarium of W. R. Gerard the mycelium on some leaves is persistent in suborbicular patches, on other leaves subpersistent and more or less effused, finally on others the mycelium is wholly evanescent and the perithecia are seated on the discolored patches of the leaf. Occasionally, too, on other hosts than *Quercus*, *M. alni* shows a persistent mycelium forming definite spots as is seen in certain specimens on *Viburnum*, *Alnus*, etc. The definite suborbicular patches of persistent mycelium could not therefore, even if constant, be considered as distinctive of "*M. densissima*."

Howe's plant, originally published as *M. sparsa* in the Journal of Botany (91) and later (168) as *M. viburni* (Schwein.) agrees with specimens of *Erysiphe viburni* Schwein. from Schweinitz's herbarium, and does not differ from ordinary *M. alni*. The same is the case with *E. ceanothi* Schwein., *E. syringae* Schwein., *M. platani* Howe, and *M. nemopanthis* Peck.

M. Ravenelii Berk. (on *Gleditschia triacanthos*), since its publication in Grevillea in 1876, has been kept distinct as a species by all authors, but neither in the type-specimen at Kew, nor in the numerous specimens so-named in American collections that I have examined, can I find any characters separating it from *M. alni*. Often the apex of the appendages is only 3 times dichotomously branched (the tips of the ultimate branches are always regularly recurved) and the plant is then identical with the usual European forms of *M. alni*; frequently, however, the apical branching is more elaborate, sometimes even extremely ornate, and then resembles that of American forms of *M. alni* on *Quercus*, *Cornus*, etc. In the type-specimen the appendages are colorless, or sometimes tinged amber-brown at the base. Burrill says "appendages usually hyaline, occasionally colored for a distance, the color ending at an abrupt line like a septum." As mentioned below the occurrence of partially colored appendages is found sporadically in many forms of *M. alni*, and no systematic value can be attached to this character.

M. semitosta Berk. & Curt., on *Cephalanthus*, has, since its publication in Grevillea in 1876, been maintained as a distinct species by

American authors. Examination of Berkeley & Curtis' type in the Kew Herbarium shows the fungus to have these characters : "perithecia 75–100 μ in diameter, appendages 5–9, ¾ to slightly longer than the diameter of the perithecium, with the tips of the ultimate branches, when mature, distinctly recurved ; asci and spores as in *M. alni.* The appendages are mostly tinged amber-brown in the lower half, and under low magnification there often seems a sharp line of demarcation between the colored basal part and the colorless upper portion. This appearance however, is due merely to the presence of air in the colored basal part, and is common to several species of *Microsphaera* and *Uncinula.* Sometimes, however, the appendages are faintly colored throughout, and the plant then shows much resemblance to "*M. erineophila* Peck," a form discussed below. Apart from the more or less colored appendages the form on *Cephalanthus* is quite similar to many examples of *M. alni* on other hosts, especially to the small form called by Léveillé "*M. Hedwigii.*"

Burrill & Earle (61, p. 414) in their key to the genus *Microsphaera* place *M. semitosta* is the section " Tips of the appendages not recurved," and *M. alni* in the section " tips recurved when mature." Burrill, too, says of *M. semitosta,* " tips obtuse not recurved." The mature apex, however, certainly shows recurved tips, and is, in all the specimens I have seen, quite similar in all respects to that of *M. alni.*

It is worthy of note that Burrill says " primary branches long "; so that it appears that the form on *Cephalanthus* sometimes shows the same kind of variation from the type as do the Japanese forms mentioned later.

The only peculiarity, then, that distinguishes *M. semitosta* is the more or less colored appendages. This character is, I am quite convinced, insufficient to separate it from *M. alni*, being one which, in the forms of this species, cannot be considered of any systematic value. In specimens of *M. alni* on *Carya sulcata* (Urmeyville, Indiana, Coll. E. M. Fisher, 1890. Ex-Herb. U. S. Dept. Agric. n. 1148 (specimen now in the Kew Herbarium)) the appendages are usually colorless, or only fairly tinged, but occasionally here and there one appendage shows a sharply marked off colored basal part like that which occurs in the *Cephalanthus* form.

In certain specimens of *M. alni* on *Vicia Americana* (usually named "*M. Ravenelii*" in herbaria) just the same occasional coloring of the appendages is found. In otherwise typical specimens of *M. alni* on various hosts I have frequently met with an occasional colored appendage, *e. g.*, in certain specimens on *Platanus occidentalis* the coloring is limited by a septum-like line exactly as in "*M. semitosta*"; and the same is the case, although rarely, with examples on *Betula alba*, where the coloring may extend to three-quarters the length of the appendage.

M. erineophila Peck * is another with colored appendages which cannot, it appears, be considered distinct from *M. alni*; Peck, in the original description, says "closely related to *M. penicillata* [*M. alni*], of which perhaps it may be a mere variety, but it is readily distinguished by its colored appendages and nucleated spores." The "nucleate" appearance of the spores may be safely disregarded as a character, and we have then only the colored appendages as a supposed distinctive character separating the plant from *M. alni*. Relying on this point, subsequent American authors have kept up *M. erineophila* as a distinct species. I cannot follow this arrangement. In the first place, as mentioned above, we find quite commonly in ordinary *M. alni* the base of the appendages becoming colored, and in the form described as "*M. semitosta*" the color usually reaches to half the length of the appendage. In a form of *M. alni* on *Carya alba* (Rab.-Wint.-Pazsch. Fung. Eur. 3953) the perithecia are exactly similar in size, and in the number and length of the appendages, to those of "*M. erineophila*," but as regards the coloring of the appendages are intermediate. The appendages of some perithecia are quite colorless, of others tinged amber brown throughout. If we were to separate the form "*M. erineophila*" from *M. alni*, the plant on *Carya alba* would certainly have to be included under the former—the appendages consequently would have to be considered as varying from colorless to colored, and in the former case the plant would only be characterized by the small size, short appendages, etc.—characters which, as we have seen in the case of *M. Hedwigii*, are quite insufficient.

With regard to *M. erineophila* on *Fagus ferruginea* there seems some connection between the coloring of the appendages

* On "erineum"—galls on the leaves of *Fagus ferruginea*.

and the occurrence of the fungus on the "erineum," as we find a form of *M. alni* with uncolored appendages, but otherwise certainly indistinguishable, on the leaves of the same host-plant when no galls are present.

On the other hand, the coloring-matter appears in the appendages of *M. alni* on other hosts without the occurrence of galls. This is well seen in the curious form of *M. alni* on *Corylus rostrata*, var. *Mandshurica* (more fully referred to later on), and also in a very interesting specimen (now in the Kew Herbarium) sent to me by Professor Galloway from the Herbarium of the U. S. Dept. of Agriculture. This specimen was labelled "*M. semitosta* B. and C. on *Cephalanthus occidentalis* Needham, Indiana. E. M. Fisher, September, 1890, No. 1154." The material consists of four leaves; three of these have traces of "erineum" on them, while the fourth is quite free. On all the leaves, however, the perithecia have appendages which are colored throughout, exactly as in "*M. erineophila*," with which the fungus often agrees in all characters. On the three leaves where galls are present, the perithecia, unlike those of "*M. erineophila*" on *Fagus ferruginea* are scattered over the surface, and occur only rarely, probably only accidentally, on the galls. Sometimes the appendages are longer (twice the diameter of the perithecium), and the apical branching shows signs of becoming more widely forked, when we are reminded of the form on *Corylus rostrata*, var. *Mandshurica*.

In conclusion it is seen from the above remarks that we have in the series of forms of *M. alni* ones that show a colored base to the appendages, others in which the appendages are colored half way ("*M. semitosta*"), and finally those in which the color reaches to the commencement of the apical branching ("*M. erineophila*," and certain forms on *Corylus rostrata*, var. *Mandshurica*, and *Cephalanthus occidentalis*) I feel convinced, therefore, that in *M. alni* the absence or presence of color in the appendages must be regarded as a character of no systematic value.

Nor can we regard *M. erineophila* as a "biological species" dependent on the gall (as is perhaps the case with *Sphaerotheca phytoptophila*), since we find the same form occurring on leaves of *Cephalanthus occidentalis* free from the "erineum."

M. alni occurs apparently only very rarely on the host plant

Menispermum Canadense. The form on this host-plant has been described as a distinct species, *M. menispermi* E. C. Howe.

Burrill (60), in his critical work on the American species of *Microsphaera*, has maintained *M. menispermi* as a distinct species. "Remarkable for the variation in structure and size. In some perithecia only one ascus is found, while in others in the same microscopical preparation at least seven have been seen. The appendages on a single perithecium are somewhat equal in length, but are often exceedingly variable in the division of the tips. Sometimes there is only a single fork with two equal, straight, obtuse branches, and again, the exceedingly ornamental tips fill the field of the microscope with its complex scroll-work."

I am indebted to Professor Underwood for sending me an authentic specimen of *M. menispermi* from the Ellis Herbarium. Examination of this specimen (now in the Kew Herbarium) showed that without doubt the fungus must be referred to *M. alni*, and, judging from this specimen alone, it cannot be considered even a marked form of this variable species. The specimen showed these characters, mycelium evanescent, perithecia more or less scattered, 100–135 μ in diameter, appendages 12–20, about equalling the diameter of the perithecium, colorless, apex 4–6 times closely and regularly dichotomously branched, tips of ultimate branches regularly and distinctly recurved, asci 4–8, spores 4–8. The branching of the apex of the appendages is often very ornate, but corresponds exactly with that of many common American forms of *M. alni*. From some of the characters given by Burrill in his description—*e. g.*, appendages sometimes seven times the diameter of the perithecium—it seems just possible that some other plant may have been under observation. However this may be, it is safe to consider *M. menispermi* E. C. Howe as a synonym of *M. alni*, as is seen by the characters shown by these authentic specimens (collected by Howe), which agree, moreover, exactly with Howe's original description.

There is a specimen in the Kew Herbarium labelled "*Microsphaera*, on *Populus*, New York, Gerard, 130." The fungus on this is *M. alni*, and the host-plant *P. grandidentata*. *M. alni* has not been reported on *Populus*, and in the present case I feel doubtful whether the perithecia originally grew on the leaves, or have

simply adhered to them. A few perithecia of *Phyllactinia corylea* occur also.

Professor Miyabe has sent me specimens (now in the Kew Herbarium) of two very interesting forms of *M. alni* from Japan. These specimens, while certainly belonging to *M. alni*, are valuable in showing what marked variations occasionally occur. The first of these forms (on *Ligustrum medium*) has often quite colorless appendages and the compact apical branching characteristic of *M. alni;* in many perithecia, however, the apex of some of the appendages forks widely, the primary branches being sometimes quite long. Not infrequently, also, the appendages are colored brown near the base, and a few perithecia were observed in which the color, although faint, reached to the base of the apical branching. The other form, on *Corylus rostrata*, var. *Mandshurica* is more remarkable, and, taken by itself, might certainly be considered distinct. The appendages of most perithecia are rather long, often twice the diameter of the perithecium, and are multiseptate and uniformly colored brown to the commencement of the apical branching. The apical branching is rather irregular, the primary branches being frequently long. Nevertheless, even in this form with usually strongly colored appendages, we get occasionally colorless appendages, and a small compact apex branched in the normal manner for *M. alni.* The wide branching of some of the appendages of these two forms tends to connect them with the var. *divaricata*, while the quite sporadic appearance of colored appendages shows that, in *M. alni*, no value can be attached to this character.

Magnus (227) in an interesting and well-illustrated paper on the forms of *M. alni*, comments on the curious fact that this species is abundant on *Syringa vulgaris* in North America, while no record exists of its occurrence on this host in Europe.

Var. **lonicerae** (DC.) [Figs. 19–22]

Erysiphe lonicerae DC. Fl. Fr. **6**: 107. 1815; Tul. Sel. Fung. Carp. **1**: 205. *pl. 2. f. 4.* 1861.

Alphitomorpha divaricata, var. *lonicerae* Schlecht. Berl. Ges. Nat. Freund. Verh. **1**: 49. 1819.

Erysibe divaricata, var. *lonicerae* Lk.; Willd. Sp. Pl. **6**: 113. 1824.

Erysiphe penicillata, var. *lonicerae* Fr. Syst. Myc. **3**: 244. 1829.

E. divaricata, var. *lonicerae* Duby, Bot. Gall. **2**: 871. 1830.

E. divaricata Lk.; Johnst. Fl. Berw. **2**: 142. 1831.

Alphitomorpha penicillata, var. *caprifoliacearum* Wallr. Fl. Crypt. Germ. **2**: 754 (partim). 1833.

Erysiphe penicillata Kickx. Fl. Crypt. Env. Louv. 138 (partim). 1835; Berk. in Sm. Engl. Fl. **5**: 327 (partim). 1836.

Erysibe penicillata, var. *caprifoliacearum* Rabenh. Deutsch. Krypt. Fl. **1**: 236 (partim). 1844.

Microsphaera Ehrenbergii Lév. Ann. sci. nat. III. **15**: 155. *pl. 8. f. 22* (sub *Calocladia*). 1851; Sacc. Syll. Fung. **1**: 14. 1882; Wint. in Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 39. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 92. 1885; Schroet.; Cohn's Krypt. Fl. Schles. **3**: 244. 1893; Jacz. Bull. l'Herb. Boiss. **4**: 748. 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 93. 1897.

M. Dubyi Lév. Ann. sci. nat. III. **15**: 158. *pl. 9. f. 26* (sub *Calocladia*). 1851; Sacc. Syll. Fung. **1**: 10. 1882.

Calocladia Ehrenbergii Lév.; Dietr. Blick. Crypt. Ostseeprov. 336. 1856; Karst. Myc. Fenn. **2**: 195. 1873.

Microsphaera lonicerae (DC.) Wint. Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 36 (excl. syn. *E. abnormis* Duby). 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 91. 1885; Schroet.; Cohn's Krypt. Fl. Schles. **3**: 243. 1893; Jacz. Bull. l'Herb. Boiss. **4**: 747. 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 89. 1897.

EXSICC.: Bri. & Cav. Fung. par. 71; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 1111, *ed. 2, ser. 1, 511; Kunze, Fung. Select. Exsicc. 319; Sacc. Myc. Ven. 891; de Thüm. Myc. univ. 450, 1056; Roumeg. Fung. Gall. Exsicc. 767, 827, 1540, 3938; Syd. Myc. March. 735, *3722, *3919; Rehm. Ascom. 349, 847; Zopf. & Syd. Myc. March. 83; Westend. Herb. Crypt. Belg. 1388; and 112 (a only) (in Herb. Jard. bot. Bruxelles), de Thüm. Fung. austr. 135; Oudem. Fung. Weerl. Exsicc. 154; Fckl. Fung. Rhen. 696; Rab.-Wint. Fung. Eur. 2651; Rab. Fung. Eur. *556; and 296 sub *M. Hedwigii*; *Erikss. Fung. par. scand. exsicc. 144, 235; Rab. Herb. Myc. ed. 2, 473.

Amphigenous; mycelium usually subpersistent and effused over the surface of the leaf, or forming patches, sometimes evanescent; perithecia gregarious or scattered, globose, depressed, very variable in size, 60–105 μ in diameter, cells 8–14 μ wide; appendages 4–30, ¾ to twice the diameter of the perithecium, colorless, smooth, aseptate or rarely 1-septate and brownish towards the base, thin-walled above, becoming thick-walled towards the base, apex 3–4 times more or less closely dichotomously branched, (rarely trichotomously branched in the branching of the first and second orders), tips of the ultimate branches mostly straight, occasionally one here and there recurved; asci 2–7, usually about 4, broadly ovate to globose, 40–56 × 34–48 μ, with or without a short stalk; spores 3–6, 20–24 × 10–12 μ.

Hosts.—*Lonicera alpigena, L. Caprifolium, L. flava, L. hispida* (95), *L. implexa, L. lutea, L. nigra, L. Periclymenum, L. tatarica, L. Xylosteum, Syringa vulgaris* (3) (227).

Distribution.—EUROPE: France, Belgium, Netherlands, Germany, Switzerland, Italy, Austria-Hungary, Sweden, Finland, Russia.

The present plant differs from *M. alni* only in the usually more loosely branched apex, with the tips of the ultimate branches for the most part straight, with occasionally one here and there recurved. At first view, one is inclined, from analogy, to consider these few recurved tips as the mature form, and to dismiss the straight ones as immature. Examination of considerable material shows, however, that this view cannot be taken, and that the recurved form is really in the present plant the exceptional one.

The extreme form of the var. *lonicerae* with a loosely and rather vaguely branched apex, with the ultimate branches more or less unequal, and their tips all straight, is very different from typical *M. alni* with its compact apex and regularly recurved tips. This is the form described by most authors, who consequently place the plant in the section of the genus characterized by having the tips of the ultimate branches not recurved. Léveillé describes this form (under the name of *M. Dubyi*), and figures the apex of the appendages as very unlike that of *M. alni.* Nevertheless, in the two specimens of "*M. Dubyi*," on *Lonicera Caprifolium* and *L. Xylosteum*, at Kew, from this author's herbarium, some perithecia may be found in which the appendages have the tips of the ultimate branches distinctly (although only here and there) recurved.

Leveillé described the plant on *Lonicera tatarica* as a distinct species—*M. Ehrenbergii*, but it is certainly not distinct from that on *L. Caprifolium*, etc. Specimens on *L. tatarica* have, perhaps, more often recurved tips here and there, and a slightly more compact branching of the whole apex, and shorter appendages than those on *L. Caprifolium*, etc., but these characters are certainly not invariable, and are, besides, frequently met with in, *e. g.*, the plant on *L. Xylosteum*, which has always been referred by authors, including Léveillé, to *Dubyi*.

The size of the perithecium and number of the appendages are very variable; I have seen perithecia, side by side on a leaf, 70 μ in diameter with 5 appendages, and 105 μ in diameter, with 22 appendages.

The var. *lonicerae* is confined to Europe; the numerous records of the plant on species of *Lonicera* in America all refer to typical *M. alni*. This is the case with Cooke and Peck's record of "*M. Dubyi*" in the Journal of Botany (90, p. 13); with Peck's records in the 26th and 29th Reports of the N. York St. Mus. (278 and 280) on *Lonicera glauca*, etc., and Saccardo's record of "*M. Dubyi*" from North America on *L. parviflora*. In these American specimens, and in the numerous other ones that I have seen in herbaria (including one named "*M. finitima* Howe," in the Kew Herbarium), the fungus clearly belongs to *M. alni*, and shows no approach whatever to the var. *lonicerae* of European honeysuckles. The apex is very ornate with regularly and distinctly recurved tips, in fact, many of the specimens show exactly the same elaborate type of branching as that of "*M. pulchra*," a form of *M. alni* on *Cornis alternifolia*.

The present plant can scarcely claim a higher rank than that of a variety of *M. alni*. Not only do we frequently find some of the tips of the ultimate branches here and there recurved, but further proof of affinity with *M. alni* is shown by the occurrence, although only very rarely, of an apex in which all the tips are recurved, and which taken by itself, would pass for that of *M. alni*. This is found, *e. g.*, in the specimens in Oudem. Fung. Neerl. Exsicc. no. 154.

As we know that *M. alni* is an extremely variable plant, all the above facts lead us to the conclusion that this species has pro-

duced on European honeysuckles a variety, *lonicerae*, characterized by a slightly different branching of the apex, but which occasionally shows signs of reverting to the type.

It is, perhaps, of interest to note that in an immature condition, the apex of the appendages of *M. alni*, is often exactly similar to the mature apex of the var. *lonicerae*.

Allescher (3) has recorded "*Microsphaera Ehrenbergii*" on *Syringa vulgaris* from Bavaria, and has stated that the *Syringa* affected stood in the immediate neighborhood of a bush of *Lonicera tatarica* attacked by the same fungus. Magnus (227, p. 68) has confirmed the identification, and considers the case to afford conclusive proof that the variety *lonicerae* (= *M. Ehrenbergii*) has here passed over from the *Lonicera* to the *Syringa*. The figure which Magnus gives (loc. cit., *f. 16*) certainly seems to represent the apical branching of the var. *lonicerae* rather than that of *M. alni* proper, a species which occurs very commonly on *Syringa* in North America.

The present variety *lonicerae* has hitherto been supposed to be the only *Microsphaera* which occurs on *Lonicera* in Europe; the occurrence of *M. alni*, var. *divaricata* on *Lonicera caerulea* in Italy is noted later.

Var. **divaricata** (Wallr.). [Figs. 23–26]

Alphitomorpha divaricata Wallr. Berl. Ges. Nat. Freund. Verh. **1** : 39. 1819; Wallr. Fl. Crypt. Germ. **2** : 754. 1833.

Erysibe divaricata, var. *frangulae* Lk.; Willd. Sp. Pl. **6** : 113. 1824.

E. divaricata (Wallr.) Schlecht. Fl. Berol. **2** : 169 (partim). 1824; Rabenh. Deutschl. Krypt. Fl. **1** : 236 (excl. syn. *Erysiphe Daphnes* Duby). 1844.

Erysiphe penicillata, var. *rhamni frangulae* Fr. Syst. Myc. **3** : 244. 1829.

E. divaricata, var. *frangulae* (Lk.) Duby, Bot. Gall. **2** : 870. 1830.

E. divaricata (Lk.) Secret. Mycogr. Suisse, **3** : 653. 1833.

Microsphaera divaricata Lév. Ann. sci. nat. III. **15** : 155. *pl. 8. f. 18* (sub. *Calocladia*). 1851; Sacc. Syll. Fung. **1** : 11. 1882; Wint. Rabenh. Krypt. Fl. Deutschl. **1**^{2} : 38. 1884;

Karst. Act. Soc. Faun. Fl. Fenn. **2** : 91. 1885; Schroet.; Cohn's Krypt. Fl. Schles. **3** : 242. 1893; Jacz. Bull. l'Herb. Boiss. **4** : 749. 1896.

Calocladia divaricata Lév.; Dietr. Blick. Crypt. Ostseeprov. 335. 1856; Karst. Myc. Fenn. **2** : 195. 1873.

EXSICC.: Fckl. Fung. Rhen. 689; Syd. Myc. March. 337; Karst. Fung. Fenn. Exsicc. 279; de Thüm. Myc. univ. 2151; Roumeg. Fung. select. exsicc. 4758; *de Thüm. Fung. austr. 140; *Westend. & Wall. Herb. Crypt. Belg. 1387; *Erikss. Fung. par. scand. 141; *Erbar. Critt. ser. 1, 142 (sub *Erysiphe lonicerae*).

Amphigenous; mycelium evanescent or subpersistent and more or less effused, or forming definite patches; perithecia gregarious or scattered, variable in size, 72–136 μ in diameter, cells 10–18 μ wide; appendages 4–16, 1½–5½, usually 3–4 times the diameter of the perithecium, flaccid when long, smooth, thin-walled above, becoming thick-walled at base when nature, colorless and aseptate, or 1–3-septate in the lower half, and then usually dark brown towards the base, apex 2–4 times dichotomously branched, primary branches usually long, divergent, and often recurved, tips of ultimate branches recurved; asci 3–7, broadly ovate to globose, usually very shortly stalked, $28–48 \times 30–38\ \mu$; spores 4–6, $18–23 \times 9–12\ \mu$.

Hosts.—Lonicera caerulea, Rhamnus Frangula.

Distribution. — EUROPE: France (307), Belgium, Germany, Italy, Austria-Hungary, Denmark, Norway, Sweden, Finland, Russia.

In its extreme form, when the appendages are long, and the apex is divided into long primary and secondary recurved branches (Figs. 24–26), the present plant seems distinct enough from *M. alni* to claim the position that all recent authors give it as a distinct species. But in the forms where the appendages are shorter—sometimes only 1½ times the diameter of the perithecium, the branching of the apex not unfrequently becomes closer (Fig. 23), and a relationship with *M. alni* is then at once apparent. Nevertheless, it would perhaps be possible to consider *M. divaricata* specifically distinct from *M. alni* if we confined ourselves to the study of European examples of the latter, relying for specific characters on the longer, flaccid appendages with a loosely-branched apex in distinction to the short, more or less rigid ap-

pendages with a much more closely and regularly branched apex of *M. alni.*

The study of American examples of *M. alni*, however, at once shows us that we have long-appendaged forms certainly connected with this species; it is impossible, *e. g.*, in face of the numerous intermediates, to regard the plant described as *M. exclusa* Cooke and Peck (a form with very long appendages) as anything but a well-marked variety of *M. alni.*

More than this, there occurs in America a plant on *Vaccinium*, etc., described as *M. vaccinii*, but which must also be regarded as a variety of *M. alni* in which we occasionally find much the same kind of apical branching as in the var. *divaricata.* It is even possible that it will eventually be found necessary to unite the American variety *vaccinii* with the European var. *divaricata.*

Considering these facts, we are forced to the conclusion that in America, where the species is apparently more abundant than in Europe, *M. alni* has varied and produced long-appendaged varieties on several host plants, while in Europe only one very similar variety has been produced on *Rhamnus Frangula.*

A further proof of the relationship of the present plant with *M. alni* is afforded by the Japanese specimens of *M. alni* on *Corylus rostrata*, var. *mandschurica*, which frequently show a loosely-branched apex with spreading branches.

Speshnew (338) records *M. divaricata* on *Rhamnus cathartica* from Transcaucasia. As this plant is a common host for *M. alni*, it will be best to wait for confirmation before accepting this record of the occurrence of *divaricata* in Asia, on a new host-plant.

Since the above remarks were written I have seen examples— one in the Herbarium of the British Museum (South Kensington), and one in the Herbarium of the Florence Museum, of the specimen no. 142 (1142) in the Exsiccati "Erb. Critt. Ital. ser. 1." (Part of the latter specimen is now deposited in the Kew Herbarium.) These specimens are labelled "*Erysiphe lonicerae*," and the host plant is *Lonicera caerulea.* The fungus, however, is not the species named (which is described above, as *M. alni*, var. *lonicerae*) but belongs to the present variety *divaricata.*

These examples on *Lonicera coerulea* have long flaccid appendages, 4–7 times the diameter of the perithecium, with often the

characteristic apical branching of typical *divaricata;* sometimes, however, the branching is slightly more compact.

This occurrence on a species of *Lonicera* is extremely interesting, as it has been hitherto supposed that the var. *divaricata* was absolutely confined to *Rhamnus Frangula,* and that the only plant which occurred on *Lonicera* in Europe was *M. alni,* var. *lonicerae.*

Var. **vaccinii** (Schwein.).

Erysiphe vaccinii Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1**: 21. 1882.

Microsphaera vaccinii Schwein. Cooke & Peck Journ. of Bot. II. **1**: 13. 1872; Peck, Reg. Rep. **23**: 65. 1873; Sacc. Syll. Fung. **1**: 13. 1882; Burr & Earle in Bull. Ill. State Lab. Nat. Hist. **2**: 417. 1887; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 70. 1891; Burr. in Ell. & Everh. N. Amer. Pyren. 25. 1892.

M. elevata Burr.; Bull. Ill. State Lab. Nat. Hist. **1**: 58. *pl. 2. f. 4, 5.* 1876; Sacc. Syll. Fung. **1**: 770. 1882; Burr & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 427. 1887; Sacc. Syll. Fung. **9**: 369. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 26. 1892.

EXSICC.: Ell. North Amer. Fung. 430; Rab.-Wint. Fung. Eur. 3539; *Seym. & Earle, Econ. Fung. 145; *Ell. & Everh. Fung. Columb. 506.

Epiphyllous, rarely amphigenous; mycelium persistent, very thin and effused over the upper surface of the leaf, or forming irregular patches, sometimes completely evanescent; perithecia globose or globose-depressed, more or less scattered, very variable in size, 70–145 μ in diameter, cells 10–20 μ wide; appendages 4–22, 2½–8 times the diameter of the perithecium, rather delicate and thin (about 5 μ wide), sometimes slightly angularly bent, flexuose, flaccid, colorless or occasionally amber-brown at the base, smooth or sometimes slightly rough towards the base or for most of the length, aseptate thin-walled above, becoming thick-walled below when mature, apex 2–4 times dichotomously branched, branching variable, sometimes very close and compact, sometimes widely forked, with the primary branches long and occasionally recurved, tips of ultimate branches regularly and distinctly recurved; asci 2–16, 45–72 × 28–38 μ, ovate or ovate-oblong, with or without a short stalk; spores 4–6, 18–22 × 10–13 μ.

Hosts.—Andromeda sp., *Catalpa bignonioides, C. speciosa, Epigaea repens, Gaylussacia resinosa, Lyonia paniculata* (371),

Vaccinium Canadense, *V. Myrtillus*, vars. *macrophyllum* and *microphyllum* (151), *V. Pennsylvanicum*, *V. vacillans*.

Distribution.—NORTH AMERICA: United States—New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Maryland, West Virginia, (249) North Carolina, Ohio, Michigan, Indiana, Alabama, Illinois, Wisconsin, Missouri, Iowa, Wyoming. Canada—Ontario.

The present plant is extremely variable in nearly all its characters.

Schweinitz, in 1834, first described the plant as growing on *Vaccinium Pennsylvanicum*, as *Erysiphe vaccinii;* in 1872 Cooke & Peck described a plant on *Vaccinium vacillans* as *Microsphaera vaccinii*, giving *E. vaccinii* Schwein. (partly) as a synonym.

Burrill has maintained *M. vaccinii* (Schwein.) Cooke & Peck as a species, and has described the appendages as "6–20, hyaline, smooth, slightly colored at base, 2 or 3 to as many as 6 times the diameter of the perithecium, branching various, usually 3 or 4 times forked, with the tips truncate or bifid, not recurved, occasionally more ornate, with tip distinctly recurved. This is a variable species not only in the character of the mycelium, but in the length and branching of the appendages. In most cases the tips are swollen and not at all recurved."

I am indebted to Professor Earle, Professor Ellis, Professor Underwood, and other American botanists for numerous specimens of the American forms of *Microsphaera* on *Vaccinium* and *Epigaea*.

In the first place, it is evident, from the study of these, that it is incorrect to consider, as has been hitherto done in America, all the forms that grow on species of *Vaccinium* as belonging to "*M. vaccinii*." On *E. corymbosum* the only fungus that I have seen is certainly to be referred to *M. alni* type; this is, no doubt, the plant recorded by Cooke & Peck (90, p. 12) as "*M. Friesii* Lév. var. *vaccinii*."

On other species of *Vaccinium*, however, and on *Epigaea*, the fungus differs from *M. alni* in having long, very flaccid, thinner appendages, with the apical branching much more variable. Burrill's description of the tips of the ultimate branches as "truncate or bifid, not recurved" undoubtedly refers to the immature condition only.

On the whole, the present plant appears clearly marked off from typical *M. alni* by the long flaccid appendages, and their usually more irregularly branched apex. It is more difficult to separate it from *M. alni* var. *extensa.* I do not think it advisable at present, however, to unite these two forms. In the var. *vaccinii* the apex of the appendages is almost constantly more irregularly and widely branched than that of the var. *extensa*, indeed the primary branches are sometimes long, divergent, and slightly reflexed as in the var. *divaricata.* In the var. *extensa* the apex is usually as ornate and as closely branched as in certain forms of typical *M. alni.* It must, however, be mentioned that cases have occurred, although very rarely, where the apical branching of the var. *vaccinii* has been quite similar to that of the var. *extensa*, and it is certainly possible that these two varieties will eventually have to be united.

I feel no hesitation in considering *M. elevata* Burrill, on *Catalpa*, as a form of the present plant.

At first sight this form, which occurs on *Catalpa bignonioides* and *C. speciosa* appears to have these distinctive characters: smaller perithecia with fewer appendages, and a smaller more closely branched apex. The size the perithecium, however, is certainly variable, not only in this form on *Catalpa*, where it ranges from 70–130 μ in diameter, but also in the plant on *Vaccinium* and *Epigaea.* In Cooke & Peck's type of *M. vaccinii* at Kew, the perithecia, although varying between wide limits, average 115 μ; in other specimens, *e. g.*, those in Ell. N. Amer. Fung. no. 430, the perithecia are smaller, about 95 μ in diameter. In specimens on *Epigaea repens*, in which the apical branching of the appendages is the same as that of the plant on *Vaccinium*, the perithecia are frequently only 85 μ in diameter. As regards the number of the appendages, this is about 14 in Cooke & Peck's type, in Ellis' specimen fewer (7 or 8), and on *Epigaea* frequently only 4 or 5. Nor is the small compact closely-branched apex of the appendages absolutely characteristic of the plant on *Catalpa*, as I have seen just the same characters in a specimen on *Vaccinium* (now in Kew Herbarium) sent to me by Professor Underwood. The same, small, compact apex is also seen in the plant on *Gaylussacia resinosa*, which has been referred by all authors to *M. vaccinii.*

Var. **extensa** (Cooke & Peck). [Fig. 18]

M. extensa Cooke & Peck, Journ. of Bot. II. **1**: 12. 1872; Peck, Reg. Rep. **25**: 1873; Sacc. Syll. Fung. **1**: 13. 1882.

M. quercina (Schwein.) Burr.; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 424 (partim). 1887; Burr.; Ell. & Everh. N. Amer. Pyren. 28 (partim). 1892.

M. quercina (Schwein.) Burr., var. *extensa* Atkins. Jour. Elisha, Mitch. Sci. Soc. **7**: 72. 1891.

Exsicc.: Rab.-Wint. Fung. Eur. 5033; de Thuem., Myc. univ. 756; Kellerm. & Swingle, Kans. Fung. 11.

Epiphyllous; mycelium persistent, effused or forming irregular spots; perithecia more or less densely gregarious, often forming floccose patches 90–140 μ in diameter, averaging 115 μ; cells 10–20 μ wide; appendages 8–19, 2½–6 times the diameter, of the perithecium, rather delicate, flexuose, flaccid, narrow (about 5 μ wide), sometimes slightly angularly bent, usually smooth, occasionally rough at the base, colorless, aseptate, thin-walled throughout, or rarely becoming thick-walled towards the base, apex 3–5 times more or less closely dichotomously branched, tips of ultimate branches regularly and distinctly recurved; asci 3–8, ovate or broadly ovate, shortly stalked, 58–72 × 34–45 μ; spores 4–8, usually 6, large, 22–26 × 12–15 μ.

Hosts.—*Quercus alba, Q. discolor, Q. nigra, Q. palustris, Q. rubra.*

Distribution.—North America: United States—Massachusetts, New York, Pennsylvania, New Jersey, North Carolina (9), Indiana, Illinois, Wisconsin, Missouri, Kansas.

The variety *extensa* differs from the type in the longer, narrower, flaccid appendages and slightly larger spores. The branching of the apex is not as a rule different from that of certain forms of *M. alni*, and is much closer and more elaborate than that of the var. *vaccinii*. Cases occur, however, although rarely, in which the manner of branching of the apex is the same in these two plants; the var. *vaccinii* can then be separated by its larger spores.

The present plant was described as a species, *M. extensa*, by Cooke & Peck, but there can be no doubt that it is too close to *M. alni* to be allowed this position. In its well-marked state the appendages are about 4½ times the diameter of the perithecium, flaccid, and narrow, and so appear very different from the stouter

(7 μ wide), more or less rigid appendages of *M. alni*. Certain specimens, however, especially some on *Quercus alba*, show all intermediate stages between *M. alni*, and the var. *extensa*, and in these it is clearly seen that as the appendages become shorter they become, *pari passu*, stouter, and gradually pass into those of ordinary *M. alni* as it occurs on oaks. The specimens in Ellis' N. Amer. Fungi, no. 429, show such intermediate stages between *M. alni* and the var. *extensa*.

Hosts.—*Quercus aquatica*, *Q. laurifolia*, *Q. nigra*.

Distribution.—NORTH AMERICA: United States—South Carolina, Alabama, Florida.

The peculiar variation of growth shown in the axial elongation of the apex of the appendages constitutes a striking character at first sight (see Figs. 15–17), and one which might, if constant, be considered of specific value.

The character, however, is certainly not invariable. On the perithecia of specimens belonging to the var. *calocladophora*, we quite commonly find single appendages which show the same regularly dichotomous apical branching as that found in the forms of *M. alni* on American oaks.

On the other hand, in certain specimens of otherwise typical *M. alni*, we find a single appendage here and there showing the axial elongation characteristic of the var. *calocladophora*. As an instance of this may be mentioned the specimens in the Herbarium at the British Museum (South Kensington) labelled "*M. extensa*, on fallen leaves of water oak. *Quercus aquatica*, Aiken, South Carolina. H. W. Ravenel, Nov., 1881," and "*M. pulchra*" on *Cornus alternifolia*. In both these specimens, among perithecia with appendages normal for *M. alni*, there occurs rarely a single appendage with the apex formed as in the var. *calocladophora*.

In the face of these connecting links on both sides, it is impossible to consider the present plant as specifically distinct. Underwood and Earle (371, p. 178) have some interesting remarks on this point.

Var. **calocladophora** (Atkins.) [Figs. 15–17]

M. densissima Ell. & Mart. Journ. Myc. **1**: 101. 1885; Sacc. Syll. Fung. Addit. ad. Vols. I.–IV.: 2. 1886 and **9**: 368. 1891.

M. calocladophora Atkins. Journ. Elisha Mitch. Sci. Soc. 7 : 73 (cum icon.). 1891 ; Burr. in Ell. & Everh. N. Amer. Pyren. 29. 1892 ; Sacc. Syll. Fung. 1 : 253. 1895.

Exsicc.: *Seym. & Earle, Econ. Fung. 179 ; Rab.-Wint. Fung. Eur. 3538 ; Ell. & Everh. N. Amer. Fung., sec. ser. 1538 ; Rav. Fung. Amer. Exsicc. 625, sub *M. extensa.*

Main axis of many of the appendages not dividing dichotomously at the apex, but growing on and bearing sets of opposite branches, which occasionally show the same axial elongation ; asci 62–75 × 42–45 μ ; spores large, 24–28 × 12–15 μ.

Var. **ludens** var. nov. [Figs. 27–30]

Perithecia more or less densely gregarious ; appendages numerous, often crowded, about 1 ½ times the diameter of the perithecium, usually flexuose-contorted or angularly bent, apex usually very irregularly and widely branched, 4–5 times dichotomous, primary branches usually rather long, and those of the subsequent orders unequal and irregularly placed, with the tips straight ; sometimes the branching is closer and more regular, with the tips distinctly recurved ; asci and spores as in *M. alni.*

Hosts.—*Vicia Americana* and vars. *linearis* and *truncata.*

Distribution.—North America : United States—South Dakota (Brookings (D. Griffiths, Aug. 1892) and Snoma (Griffiths and Carter, Aug. 1897)), Wyoming (French Creek, Williams and Griffiths, Aug. 1898).

Among the duplicate specimens (now in the Kew Herbarium) sent to me from the fine collection of Erysiphaceae made by Griffiths in Dakota, Wyoming and Montana there are examples of a *Microsphaera*, growing on the species of *Vicia* named above, which are very difficult to place.

Griffiths has named and recorded this *Microsphacra* as *M. diffusa.* This led me to examine again all the material of *M. diffusa* at my disposal, and to compare them with the present plant.

From all specimens seen of *M. diffusa* Griffiths' plant differs in possessing, frequently, a recurved tip to the ultimate branches. Sometimes we find a single appendage with the tips all regularly and distinctly recurved, and the mode of branching of the whole apex not very unlike that of *M. alni*, and certainly like that of some of its varieties, *e. g.*, var. *divaricata* (Figs. 28, 30). On the other hand a large proportion of the appendages show an apical

branching of a very different type to that of *M. alni;* the branching being very lax and irregular, with straight tips to the ultimate branches (Figs. 27, 29).

In the latter case there is much resemblance to *M. diffusa*, but in that species we find the ultimate divisions (of the mature apex) forming long, rather slender, nearly parallel branches. These long ultimate branches are characteristic of *M. diffusa*, and are not found in the present plant, in which, moreover, as mentioned above, we frequently find some appendages with recurved tips, another character which never occurs in *M. diffusa.*

The appendages of the present plant are usually angularly bent, or even more or less contorted; this character together with that of the great variability in the apical branching, give much the appearance of a "sport"; but as the plant has been collected in three different localities on different host plants, it can hardly be dismissed as this.

M. euphorbiae has the same curiously contorted appendages, but differs in the longer appendages, with very flexuous apical branching, etc. If we consider the bent appendages as a character of the first importance, the present plant should rank as a variety of *M. euphorbiae* rather than of *M. alni*; but it is possible that the more or less contorted growth of the appendages is due, in the present case, merely to the great crowding of the perithecia and the consequent interlacing of their appendages. Moreover, in some perithecia the appendages are nearly or quite straight; this is, however, very exceptional.

Except in the very variable nature of the apical branching, and the contorted appendages, the present plant does not differ from *M. alni.*

The usually very lax and irregular apical branching certainly separates the present plant widely from the ordinary forms of *M. alni*, and it is only the occasional occurrence of appendages with recurved tips and a closer type of branching that has led to its being placed, with some hesitation, as a new variety under *M. alni.*

It may be well here to review the position of these six varieties of *M. alni.* In America we have the four varieties *extensa*, *calocladophora*, *vaccinii*, and *ludens.* The position of these to the type may be stated as follows:

Var. *extensa* is a robust form produced on certain species of oaks, and in its extreme state is very distinct in the long flaccid appendages. The apical branching does not deviate from the ornate type commonly found in American examples of *M. alni* on oaks. The spores appear to be distinctly larger. A complete series of intermediate forms exist connecting this variety with the type.

Var. *calocladophora* is another robust form, similarly confined to certain American oaks. The distinguishing character is the axial elongation shown in the apex of most appendages. The spores are large. Connecting links, both on the side of the variety and of the type, are occasionally found.

Var. *vaccinii* differs from the two varieties mentioned above in the smaller spores, and in the variable nature of the apical branching of the appendages. The long, thin appendages and usually looser apex distinguish it from the type, although as the appendages tend to become shorter, they become stouter, with the apical branching more approaching that of *M. alni.* Certainly allied to the European var. *divaricata.*

Var. *ludens* occurs on *Vicia Americana*, and is known at once by the more or less contorted appendages, with very lax and variable apical branching. The tips of the ultimate branches are very frequently straight.

The two European varieties are *lonicerae* and *divaricata.*

Var. *lonicerae.*—This has perhaps some claim to be considered a distinct species which has been evolved on species of *Lonicera* in Europe, perhaps in the same way as *M. berberidis* has on *Berberis;* to this species, indeed, the present variety shows some affinity. On the other hand, relationship with *M. alni* is shown in the fact that the characteristically straight tips of the var. *lonicerae* are occasionally recurved as in this species.

Var. *divaricata.*—This has hitherto been supposed to be confined to *Rhamnus Frangula;* a single occurrence, however, on *Lonicera nigra* has been noted. In its extreme form this variety is very different from any European forms of *M. alni* in the long, divergent, usually reflexed branches of the apex of the long appendages. Occasionally, however, the appendages are shorter, and the apical branching more like that of *M. alni.* Intermediate forms also

exist. This variety shows great affinity with certain forms of the American var. *vaccinii*.

5. M. GROSSULARIAE (Wallr.) Lév. [Figs. 34, 37 and 43]

Alphitomorpha penicillata, var. *grossulariae* Wallr.; Berl. Ges. Nat. Freund. Verh. **1** : 40. 1819; Wallr. Fl. Crypt. Germ. **2** : 755. 1833.

A. grossulariae Wallr. Ann. Wett. Ges. **4** : 236. 1819.

Erysibe penicillata, var. *grossulariae* Lk.; Willd. Sp. Pl. **6** : 114. 1824; Rabenh. Deutschl. Krypt. Fl. **1** : 236. 1844.

Erysiphe penicillata, var. *grossulariae* Fr.; Syst. Myc. **3** : 244. 1829; Duby, Bot. Gall. **2** : 871. 1830.

E. penicillata Spreng.; Fl. Hal. 581 (partim). 1832; Berk. Sm. Engl. Fl. **5** : 327 (partim). 1836.

Microsphaera grossulariae Lév. Ann. sci. nat. III. **15** : 160. *pl. 9. f. 25* (sub *Calocladia*). 1851; Cooke, Micr. Fung. 220. 1865; Cooke, Handb. Brit. Fung. **2** : 649. 1871; Wint. Rabenh. Krypt. Fl. Deutschl. **1**^{2} : 37. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2** : 91. 1885; Burr. Ell. & Everh. N. Amer. Pyren. 24. 1892; Schroet. Cohn's Krypt. Fl. Schles. **3** : 244. 1893; Jacz. Bull. l'Herb. Boiss. **4** : 747. 1896; Oudem. Rév. Champ. Pays.-Bas. **2** : 90. 1897.

Calocladia grossulariae (Lév.) Dietr. Blick. Crypt. Ostseeprov. 337. 1856.

Erysiphe grossulariae (Lév.) de Bary, Beitr. Morph. Phys. Pilz., **1** : § xiii. 52. 1870.

Microsphaera Van-Bruntiana Ger. Bull. Torr. Club, **6** : 31. 1875; Sacc. Syll. Fung. **1** : 14. 1882; Atkins. Journ. Elisha Mitch. Sci. Soc. **7** : 71. 1891.

Podosphaera grossulariae (Lév.) Quél. Champ. Jur. Vosg. **3** : 106. 1875.

EXSICC.: Rab. Fung. Eur. 1044; Fckl. Fung. Rhen. 697; Roumeg. Fung. Gall. Exsicc. 1539, 2167; Syd. Myc. March. 734; de Thüm. Fung. austr. 136, 460; Ell. N. Amer. Fung. 769, 1324; Cooke, Fung. Brit. Exsicc. ed. sec. 284; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 1110, *ed. sec., ser. 1, 510; Vize. Fung. Brit. 94; Flor. Gall. et Germ. Exsicc. 598; Rab.-Wint. Fung. Eur. 3247; Rehm. Ascom. 849; *de Thüm. Myc. univ. 2242; *Ell.

& Everh. Fung. Columb. 315; *Erikss. Fung. par. scand. 142; *Krieg. Fung. saxon. 725.

Epiphyllous or amphigenous; mycelium evanescent, or subpersistent, thin and effused on the upper surface of the leaf; perithecia scattered to densely gregarious, globose-depressed, very variable in size, 65–130 μ in diameter, cells 14–20 μ wide; appendages 5–22, 1–1¾ times the diameter of the perithecium, colorless, smooth, aseptate, thin-walled above, becoming thick-walled in the lower half, when mature, apex 4–5 times closely and regularly dichotomously branched, branches of the first and second orders very short, all the segments deeply divided (giving a somewhat digitate appearance to the whole apex), ultimate branches forming a narrow fork, tips not recurved; asci 4–10, broadly ovate or oblong, usually with a very short stalk, 46–62 × 28–38 μ; spores 4–6, very rarely only 3, variable in size, 20–28 × 12–16 μ.

Hosts.—*Ribes floridum* (6), *R. Grossularia*, *R. nigrum* (6), *R. rotundifolium* (6), *R. sanguineum*, *Sambucus Canadensis*, *S. racemosa* and var. *pubescens*.

Distribution.—EUROPE: Britain, France, Belgium, Netherlands (263), Germany, Switzerland, Austria-Hungary, Denmark, Sweden, Finland (196), Russia.

ASIA: Japan.

NORTH AMERICA: United States—Vermont, Massachusetts, New York, Pennsylvania, West Virginia (249), North Carolina (13), Ohio, Indiana, Alabama (12), Illinois, Wisconsin, Missouri, Kansas (386), Montana (6), California (159).

A well-marked species in the deeply divided segments of the appendages. The branches of the first and second orders are very short, so that the divisions of the segments reach nearly to the center, giving a somewhat digitate and very characteristic appearance to the whole apex (see Figs. 34, 35).

The American *M. Van-Bruntiana* (on *Sambucus Canadensis*) is identical with the present species, although in the original description the branches of the appendages are described as "truncate at their apices." When mature, however (Fig. 43), the branches are bifid in just the same manner as in *M. grossulariae*, and the original description was no doubt taken from an immature appendage, such as is shown at Fig. 36, drawn from an American specimen.

M. grossulariae is confined in Europe to *Ribes Grossularia;* in America it attacks several other species of *Ribes*, and also, very frequently, *Sambucus Canadensis* and *S. racemosa*.

Professor Miyabe has sent me specimens on *Sambucus racemosa* var. *pubescens* from Japan. This is the first record of the occurrence of the species in Asia.

In Europe *M. grossulariae* sometimes occurs in such quantities on cultivated gooseberries as to cause a disease. In the Journal of the Board of Agriculture for 1898 (184) it is reported that this disease was very troublesome in England during that year, causing the leaves of the gooseberry-bushes affected to shrivel and fall off. The following notes on prevention and remedies are given: "The leaves from infected bushes should be raked from under them and burnt. . . Any dead leaves remaining on infected trees should be picked off and burned, as far as possible. Where there is a sign of infection the leaves should be dusted thoroughly above and below with very finely powdered sulphur put carefully on with a knapsack powder-distributer on a still, hot, sunny day. Sulphide of potassium diluted with water in the proportion of 2½ oz. of sulphide to five gallons of water, and sprayed over and under the leaves in a fine spray, has been found to be efficacious. This dressing should be applied very early when the leaves are small and young, and should be repeated in about sixteen days." Bordeaux mixture, composed of 3 lbs. of sulphate of copper and 3 lbs. of lime to 25 gallons of water, or if used later in the season when the foliage is strong and fully developed, composed of 4 lbs. of sulphate of copper and 4 lbs. of lime to the same quantity of water, is also recommended.

The American "gooseberry mildew," which attacks chiefly the berries, is *Sphaerotheca mors-uvae*.

6. M. MOUGEOTII Lév. [Figs. 59, 60]

M. Mougeotii Lév. Ann. sci. nat. III. **15**: 158. *pl. 9. f. 24* (sub *Calocladia*). 1851; Cooke, Micr. Fung. 219. 1865; Cooke Handb. Brit. Fung. **2**: 649. 1871.

Erysiphe Mougeotii de Bary, Beitr. Morph. Phys. Pilz. **1**: § xiii. 52. 1870.

Podosphaera Mougeotii (Lév.) Quél. Champ. Jur. Vosg. **3**: 106. 1875.

Microsphaera Lycii (Lasch.) Sacc. & Roum. Michelia, **2**: 310. 1881; Sacc. Syll. Fung. **1**: 10. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 37. 1884; Schroet.; Cohn's Krypt. Fl. Schles. **3**: 243. 1893; Jacz. Bull. l'Herb. Boiss. **4**: 745. 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 89. 1897.

EXSICC.: de Thuem. Fung. Austr. 461; Roumeg. Fung. Gall. exsicc. 1165, 2740; Rab. Fung. Eur. 1428; Syd. Myc. March. 837; de Thuem. Myc. Univ. 2152.

Amphigenous; mycelium thin, effused and subpersistent, or evanescent; perithecia usually epiphyllous, sub-gregarious or scattered, globose-depressed, 115–170 μ in diameter, cells obscure, 8–13 μ wide; appendages very numerous and densely crowded, about equalling the diameter of the perithecium, flaccid, thin-walled throughout, aseptate, smooth, colorless, sometimes slightly nodulose, apex 2–3 times dichotomously branched, or occasionally, especially in the branching of the first order, trichotomously divided, branching very loose, irregular, and widely spreading, tips of ultimate branches not recurved; asci 10–18, ovate or ovate-cylindrical, often somewhat truncate at apex, shortly stalked, 48–56 × 24–30 μ; spores 2, 20–24 × 12–15 μ.

Hosts.—*Lycium barbarum*, *L. Europaeum*, *L. ovatum* (56) (319), *L. ruthenicum* (307) (394).

Distribution.—EUROPE: Britain, France, Belgium (44) (209), Netherlands (263), Germany, Italy (307), Austria-Hungary, Russia, (172).

A very distinct plant, differing from all other species of the genus in the densely crowded, widely branched appendages and the 2-spored asci.

The appendages at first spread upwards, so that the perithecium, seen from above, appears enveloped in a white mycelium-like mass; eventually the appendages become reflexed, and the exposed upper half of the perithecium becomes concave. The appendages usually branch at about half their length, and fork widely, measuring from 100–150 μ across the apex.

M. Mougeotii is confined to Europe; the species recorded under this name from North America proves to be *M. diffusa*.

Saccardo and Roumeguere, followed by all modern authors, uses the name *M. Lycii* (Lasch.) for the present species. This name, however, published in Sacc. Fung. Gall. ser. III. no. 1174 (1850),

was not accompanied by a diagnosis, and therefore cannot take precedence over Léveillé's name *Mougeotii* (1851).

7. M. DIFFUSA Cooke & Peck. [Figs. 31–33]

M. diffusa Cooke & Peck, Journ. of Bot. II. **1**: 13. 1872; Peck, Reg. Rep. **25**: 95. 1873; Sacc. Syll. Fung. **1**: 12. 1882; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 416. 1887; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 69. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 24. 1892.

M. symphoricarpi E. C. Howe, Bull. Torr. Club, **5**: 3. 1874; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 417. 1887; Sacc. Syll. Fung. **9**: 369. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 24. 1892.

Exsicc. (sub *M. diffusa*): Ell. & Everh. N. Amer. Fung. sec. ser. 1540; Rab.-Wint. Fung. Eur. 3654; Rav. Fung. Amer. Exsicc. 628. (Sub *M. symphoricarpi*); Rab.-Wint. Fung. Eur. 3655; Ell. N. Amer. Fung. 768; Rehm. Ascom. 846; *Ell. & Everh. Fung. Columb. 224.

Amphigenous; mycelium persistent, thin and effused, or sub-persistent and forming vague patches, or quite evanescent; perithecia scattered or gregarious, globose-depressed, very variable in size, 55–126 μ in diameter, averaging 90–100 μ, cells 10–20 μ wide; appendages very variable in number and length, 4–30, or rarely crowded and as many as 50, 1½–7 times the diameter of the perithecium, smooth, aseptate or 1–3-septate in the lower half, colorless or pale brown towards the base, flaccid when long, thin-walled above, becoming thick-walled towards base, apex 3–5 times dichotomously or sub-dichotomously divided, branching diffuse and irregular, branches of the higher orders sub-nodulose, often apparently lateral, tips of ultimate branches not recurved; asci 4–9, 48–60 × 28–30 μ, ovate-oblong with a very short stalk; spores 3–6, usually 4, 18–22 × 9–11 μ.

Hosts.—(Sub *M. diffusa*) *Apios tuberosa*, *Desmodium Canadense*, *D. canescens* (265) (324) 366), *D. cuspidatum* (61), *D. paniculatum*, *D. sessilifolium*, *Glycyrrhiza lepidota*, *Lespedeza capitata*, *L. hirta*, *L. striata*, *L. violacea*, *Phaseolus perennis*. (Sub *M. symphoricarpi*) *Symphoricarpos occidentalis*, *S. orbiculatus*, *S. racemosus* and var. *pauciflorus* (6).

Distribution.—NORTH AMERICA: United States (sub *M. diffusa*) —Connecticut, New York, Pennsylvania, South Carolina, Ohio

(324), Michigan, Alabama, Illinois, Mississippi, Wisconsin, Missouri, Iowa, Minnesota, South Dakota, Kansas, Montana, Wyoming. (Sub *M. symphoricarpi*) Pennsylvania, Virginia, Ohio, Indiana, Illinois, Missouri, North and South Dakota, Kansas, Montana, Idaho, Colorado, California, Washington.

A species very variable in every character except the irregular diffuse branching of the apex of the appendages, in which a good specific distinction is found. The dichotomous nature of the branching ceases in the higher orders, so that the youngest branches are irregularly arranged, and often appear as lateral outgrowths ; a slightly nodulose appearance of the branches is also characteristic of the present species (see Figs. 31, 32).

After seeing a large amount of material, I feel convinced that the plant on *Symphoricarpos—M. symphoricarpi*, E. C. Howe, should be referred to *M. diffusa*. In this form the perithecia are perhaps slightly smaller on the average, although the size varies greatly (I have seen contiguous perithecia on a leaf measuring 55 μ and 104 μ in diameter) ; the appendages are usually fewer (4–24), and tend to become longer than in typical *M. diffusa ;* but these characters are not constant. In certain specimens on *Symphoricarpos*, perithecia taken from the same leaf show a variation in the length of the appendages of from 1 ½ to 7 times the diameter of the perithecium ; while, on the other hand, *M. diffusa* on other host-plants frequently possess appendages reaching to four times the diameter of the perithecium,* and as few as 12 in number. In the peculiar character of the apical branching of the appendages the form on *Symphoricarpos* agrees well with *M. diffusa*, and as this is, I consider, the most important specific character, I feel little hesitation in treating the two plants as one species. It is necessay to point out that in the form on *Symphoricarpos* the appendages are very slow in reaching their full development, and unless perfectly mature examples are examined, the apex of the appendages appears less diffusely branched. In specimens with a fully developed apex, however, as is the case, *e. g.*, with those on *S. occidentalis* (Fort Collins, Colorado (C. F. Baker)) and on *S. racemosus* (Datah Co., Idaho, June, 1897 (L. F. Henderson)) both

* Burrill & Earle (61, p. 417) mention specimens on *Lespedeza capitata* with appendages "5 or 6 times the diameter."

in Professor Earle's Herbarium—the identity in the nature of the apical branching of the form on *Symphoricarpos* and of *M. diffusa* on other hosts is clearly seen.

Burrill (60) remarks on "*M. symphoricarpi* (which is given specific rank)"; "much like some forms of *M. vaccinii.*" The latter plant is, however, far removed in the distinctly recurved tips of the ultimate branches of the apex of the appendages.

M. diffusa has been recorded on *Lathyrus ochroleucus* by Burrill (60) and Trelease (366). From the remarks of the latter author, however, that the appendages were "absolutely indistinguishable from those of *M. pulchra* " there can be no doubt that the fungus was really *M. alni*. *Vicia* is also given as a host-plant by Burrill (60) for the present species, but it seems probable that *M. alni*, var. *ludens* has been mistaken for *M. diffusa* in this case. I have seen specimens of typical *M. alni* on both *Lathyrus ochroleucus* and *Vicia Americana.*

The records of *M. Mougeotii* Lév. (*M. Lycii*) from America belong to the present species.

8. M. Russellii Clinton. [Figs. 38, 39]

M. Russellii Clinton; Peck, Reg. Rep. **26**: 80. 1874; Sacc. Syll. Fung. **1**: 12. 1882; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 415. 1887; Burr.; Ell. & Everh. N. Amer. Pyren. 23. 1892.

Exsicc.: Ell. & Everh. N. Amer. Fung. sec. ser. 2008, 3517; *Seym. & Earle, Econ. Fung. 270a, 270b;* Ell. & Everh. Fung. Columb. 507.

Amphigenous; mycelium evanescent, or subpersistent; perithecia scattered, 70–118 μ in diameter, globose-depressed, cells small, 6–14 μ wide; appendages 5–14, 3–7 times the diameter of the perithecium, flaccid, septate, smooth, colored nearly to the apex when mature, apex 2–4 times dichotomously branched, branching very irregular and lax, primary branches usually long and forking widely, tips of ultimate branches not recurved; asci 4–9, narrowly to broadly ovate, or (in small perithecia) ovate-globose, shortly stalked, $42–56 \times 24–32\ \mu$; spores 3–5, usually 4, $18–22 \times 10–12\ \mu$.

Hosts.—Oxalis corniculata, var. *stricta*, *O. Suksdorfii*, *O. violacea* (60).

Distribution.—NORTH AMERICA : United States—Vermont, New Hampshire, Massachusetts, New York, West Virginia (249), Ohio, Indiana, Illinois, Wisconsin, Missouri, Iowa, Washington. Canada —Ontario.

Very distinct among the species of the genus in the long flaccid colored appendages. The nature of the final branching of the apex of the appendages is very hard to see in *M. Russellii*, as in this species, as in many of the genus *Microsphera*, the appendages are extremely slow in arriving at maturity, and perithecia are frequently found in which the asci and spores are formed, although the appendages are still unbranched. Figs. 38, 39 represent the most branched form of the apex of the appendages that I have seen. Burrill (60) says "appendages simple, bifid, or two or three times irregularly branched, branches long, often distorted, tips not swollen or recurved."

9. M. EUPHORBIAE (Peck) Berk. & Curt.

Erysiphe euphorbiae Peck, Reg. Rep. **26** : 80. 1874 ; Sacc. Syll. Fung. **1** : 18. 1882.

Microsphaera euphorbiae Berk. & Curt. Grevillea, **4** : 160. 1876 ; Sacc. Syll. Fung. **1** : 13. 1882 ; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2** : 418. 1887 ; Atkins Journ. Elisha Mitch. Sci. Soc. **7** : 70. *pl. 1. f. 1–4.* 1891 ; Burr.; Ell. & Everh. N. Amer. Pyren. 26. 1892.

M. coluteae Kom. Scripta Bot. Hort. Univ. Imp. Petropol. **4** : 270. 1895.

EXSICC.: Ell. N. Amer. Fung. 431 ; Rab.-Wint. Fung. Eur. 3246 ; Jacz.-Kom.-Tranz. Fung. Ross. Exsicc. 79.

Amphigenous ; mycelium usually subpersistent, thin and effused, sometimes evanescent ; perithecia often gregarious in floccose patches, but sometimes scattered, 85–145 μ in diameter, rarely reaching to 180 μ, globose-depressed, cells 10–15 μ wide ; appendages 7–28, 2½–8 times the diameter of the perithecium, usually narrow (about 5 μ wide), more or less flexuose-contorted angularly bent, and nodulose, but sometimes wider and not angularly bent, always very flexuose, colorless, thin-walled above, becoming thick-walled in the lower half, aseptate, sometimes slightly rough, apex 3–4 times dichotomously branched, branching very irregular and lax, branches strongly flexuose, often more or less curled, lips of ultimate branches straight or recurved ; asci

4–13, more rarely 13–26, ovate or ovate-oblong, with a short stalk, 48–66 × 26–35 μ; spores usually 4, sometimes 3, 5 or 6, 19–21 × 10–12 μ.

Hosts.—Astragalus adsurgens, A. Cooperi, A. Drummondii, A. Mortoni, Colutea arborescens, C. cruenta, Euphorbia corollata, E. hypericifolia, E. marginata (60) (386), *E. Preslii.*

Distribution.—ASIA: Turkestan.

NORTH AMERICA: United States—New York, North and South Carolina, Michigan, Alabama (12), Illinois, Mississippi, Wisconsin, Missouri (363), Iowa, Kansas, Montana, Colorado.

A very interesting and marked species in the contorted angularly-bent appendages, which occur almost constantly in all examples, and when present, are sufficient, taken in conjunction with the flexuose branching of the apex, to identify the species at once. Where the appendages are not thus characterized, *e. g.*, as in the form on *Colutea* (referred to below), the best distinctive character is found in the very vaguely and widely branched apex of the appendages, the branches of which are irregularly arranged, very flexuose, or variously contorted and twisted.

Up to the present time, *M. euphorbiae* has been considered as occurring only on species of *Euphorbia*, but I have no hesitation in referring to this species American plants occurring on *Astragalus adsurgens, A. Cooperi, A. Drummondii,* and *A. Mortoni.* The fungus on *A. Cooperi* has been recorded by Peck (60) (91) (280) as "*M. holosericea* Lév." [*M. astragali*]; that on *A. adsurgens* I have found labelled "*M. Ravenelii*" in herbaria, and that on *A. Mortoni* named *Erysiphe communis.* All the specimens on the species of *Astragalus* mentioned above have the same peculiarly contorted appendages and irregular branching of the apex as occur in examples of *M. euphorbiae* on species of *Euphorbia.*

Komarov (206) has recently described a species of *Microsphaera*, occurring on *Astragalus* and *Colutea* in Turkestan, under the name of *M. coluteae*, with the following diagnosis: "Bifrons, mycelio arachnoideo, persistente, bene evoluto. Conceptaculis minutis subglobosis. Appendiculae graciles, conceptaculo multo longiores, uncinatae, ramulis ultimis apice turgidis incurvis. Asci 8 subovoidei brevi pedunculati. Sporae in quovis asco 2–6, saepius 3–4. Conidiis cylindrico-ovoideis. Conceptacula ad 90 μ;

appendices 300–400 μ; asci 42–45 × 22–50 μ; sporae 14–22 × 5–14 μ; conidia 28–32 × 10–13 μ."

I have seen the following examples, of this plant: Jacz.-Kom.-Tranz. Fung. Ross. Exsicc. nr. 79, "in fol. vivis *Astragali* sp. Ad. fluv. Seravschan (Turkestan)"; a specimen in the Herbarium of the University of St. Petersburg, from "Darch, 6000 feet. Seravschan" super, "on *Colutea cruenta* Ait."; and a specimen from the same locality as the last, on *Colutea arborescens*, in Professor Tranzschel's herbarium. These two forms on *Colutea* and *Astragalus* are sightly different. On the former host-plant the fungus forms conspicuous floccose patches, due chiefly to the appendages being more assurgent than usual; the perithecia are large, 100–180 μ in diameter, the appendages are 7–28 in number, and very long, reaching sometimes to 8 times the diameter of the perithecium, not angularly bent, nor nodulose, though very flexuose, usually slightly rough for nearly the whole length; the apical branching is very wide—often measuring more than 200 μ wide—and irregular, and the branches are very flexuose and contorted; the asci are 6–23 in number, with 4–5 spores. On *Astragalus* the appendages are intricately contorted and angularly bent, but the branching of the apex is often identical with that of the form on *Colutea*, although the branches are frequently even more flexuose and curled, the ultimate ones being sometimes almost spirally coiled. Good figures of these two forms have been given by Magnus (231. *f. 8–13*).

The characters shown in the branching of the apex, and, in the form on *Astragalus*, in the peculiar contorted appearance of the appendages, certainly in my opinion, refer "*M. coluteae*" to *M. euphorbiae*. I had already, before seeing Komarov's specimens, referred American forms on certain species of *Astragalus* to *M. euphorbiae*, and I now feel convinced that we have this species occurring in North America on *Euphorbia* and *Astragalus*, and in Asia on *Astragalus* and *Colutea*.

I have not seen any examples of *M. euphorbiae* from Europe. Bommer and Rousseau (45) have recorded "*Erysiphe euphorbiae* Peck," in a conidial stage on *Euphorbia amygdaloides* from Belgium; it is quite possible, however, that this fungus may prove to be *Sphaerotheca tomentosa* (*S. mors-uvae*). European specimens in

herbaria, named *E. euphorbiae* Peck" have all proved on examination to be this species of *Sphaerotheca*. Lambotte (209 supp.), however, records a plant from Belgium, which may possibly belong to *M. euphorbiae*. It is recorded as "*Erysiphe euphorbiae* Peck," but the brief description given is not sufficient to identify the plant with certainty; Thèques largement ovées 3–4, spores 3–4, épaisses, 25 × 16; appendices peu longs, flexueux, colorés; périthèces petits; mycelium mince. Feuilles d'Euphorbe."

I follow Burrill in regarding *Microsphaera euphorbiae* Berk. & Curt. as identical with *Erysiphe euphorbiae* Peck; I have not seen an authentic specimen of the latter. Burrill speaking of *M. euphorbiae*, says (60, p. 26) "*Erysiphe euphorbiae* is evidently the same thing. The name seems to have been founded upon specimens in which the appendages were not branched."

10. M. GUARINONII Bri. & Cav. [Figs. 42, 44]

M. Guarinonii Bri. & Cav. Fung. Par. n. 172 (cum diag. et icon.). 1892; and in Hedwigia, **31**: 142. 1892; Cav. in Atl. Istit. Bot. Pavia, II. **3**: 329. 1894; Sacc. Syll. Fung. **11**: 252. 1895.

EXSICC.: Bri. & Cav. Fung. Par. 172.

Amphigenous; mycelium subpersistent, effused; perithecia more or less densely gregarious, 90–126 μ in diameter, globose-depressed, cells large, evident, 12–20 μ wide; appendages 8–20, 8–12 times the diameter of the perithecium, colorless, flexuose, aseptate, smooth, hyaline and thin-walled almost to base, apex 3–4 times dichotomously branched, branching usually lax with the primary branches long, widely spreading, and more or less recurved, sometimes more compact, tips of ultimate branches recurved when mature; asci 4–10, ovate-oblong, with or without a short stalk, 55–68 × 30–38 μ; spores usually 6, sometimes 4 or 5, 20–23 × 10–13 μ.

Host.—Laburnum vulgare.

Distribution.—EUROPE: Italy.

A very beautiful species, quite distinct in the very long, flexuose appendages, 3–4 times dichotomously branched, with the tips of the ultimate branches recurved.

Briosi and Cavara show the ultimate branches recurved, but figure the tips of these as straight; this, however, is not the form of the mature apex (see Figs. 42, 44). The asci are described as

8-spored, but in the specimens I have examined no ascus has contained more than 6 spores.

M. Guarinonii has hitherto been recorded from only a single locality in Italy—Varallo, where it was discovered in 1891, and published the next year in Briosi and Cavara's Exsiccati. I have, however, seen specimens from two other Italian localities. One is contained in the Herbarium of the Florence Museum. This specimen was named *Erysiphe Martii*, "on the leaves of *Cytisus Laburnum*, Boscolongo, 1877 (Da Borzi)," with the note attached "appendicibus longissimis hyalinis, ascis ovatis in pedicello productis, 8-sporis." The other specimen was recorded by Massalongo (237, p. 127) as "*M. astragali β cytisi*," from S. Mauro di Saline, Verona, October 5, 1892.

11. M. UMBILICI Kom. [Figs. 45, 46]

M. umbilici Kom. Scripta Bot. Hort. Univ. Petropol. **4**: 270. 1895.

EXSICC.: Jacz.-Kom.-Tranz. Fung. Ross. Exsicc. 29.

Amphigenous; mycelium evanescent; perithecia scattered or gregarious, 90–142 μ in diameter, cells 10–15 μ wide; appendages 4–10, 1–1¾ times the diameter of the perithecium, not flaccid, aseptate and colorless, or brownish at base and 1–3-septate, apex (? mature) 4–5 times dichotomously branched, branching rather close, branches of the higher orders more or less irregularly placed, tips of the ultimate branches not recurved; asci 4–14, ovate-oblong, shortly stalked, 58–70 × 23–38 μ; spores 3–5, 22–25 × 10–13 μ.

"Mycelio arachnoideo persistente, matricis superficiem totam occupante. Peritheciis minutis subglobosis. Appendiculae perithecis aequantes rectae breves ad basin leniter coloratae, ramulis ultimis apice turgidis. Ascis in quovis perithecio 5–8, ovoideis vel ellipsoideis brevipedunculatis; sporis 3–2 cylindrico ovoideis. Conidiis cylindricis utrinque rotundatis. Peritheciis 90–120 μ; appendiculis 90–130; ascis 40–54 × 30–45; sporis 16–22 × 8–12; conidiis 25–32 × 8–12" (Kom. *loc. cit.*).

Host.—*Cotyledon Semenovii* (= *Umbilicus Semenovii*).

Distribution.—ASIA: Turkestan (Seravschan).

I have not seen sufficiently mature examples of this plant to be able to express an opinion as to its position. The only specimens examined (from which my description was drawn up) have been those

in the exsiccati quoted. These specimens, although many perithecia contain asci and spores, are too immature to show with certainty the form of the mature apex of the appendages. The most developed stage in the branching of the apex that I have seen is shown at Fig. 45. It is, however, possible that this does not represent the final form, and the somewhat swollen tips of many of the branches rather favors the view that further division takes place. It is frequently the case in species of *Microsphaera* that the asci and spores are developed long before the apical branching of the appendages has attained its mature form.

12. M. FERRUGINEA Erikss. [Figs. 56–58]

M. ferruginea Erikss. Fung par. scand. n. 145 (cum diag.) 1883; Erikss. Bidr. Känned. vara odl. växt. sjuk. 46. 1885.

EXSICC. *Erikss. Fung. par. scand. 145.

Amphigenous; mycelium subpersistent; perithecia scattered, 70–100 μ in diameter, cells small, rather regular, 10–12 μ wide; appendages 4–7, rarely 7–10, about 1½ times the diameter of the perithecium, colorless, smoth, thin-walled above, becoming thick-walled below, apex 3–4 times dichotomously branched, branching rather vague and lax, tips of the ultimate branches not recurved; asci 4–6, ovate-oblong, with or without a short stalk, $45–52 \times 26–30\ \mu$; spores 4–?, $20 \times 13\ \mu$.

"Caespites amphigeni, ferruginei, pulveracei, demum late effusi et confluentes. Conidia utrinque rotundata, pallide fusca, pellucida, 28–32 μ longa, 16–18 μ lata. Perithecia fusco-atra, sparsa, mycelio densissimo arachnoideo persistente intexta, 80–90 μ in diam. Appendices 6–10, perithecium aequantes vel duplo longiores, 4–6: eis dichotomae, hyalinae. Asci 6–8 in quoque perithecio, 44–50 μ longi, 26–30 μ lati. Sporae 6–8 in quoque asco, 16–18 μ longae, 10–12 μ latae. (Erikss. *loc. cit.*)

Host.—*Verbena hybrida* (cult.).

Distribution.—EUROPE: Sweden.

The specimen which Professor Eriksson kindly sent to me for examination from his herbarium, and that in the Exsiccati quoted, are unfortunately both immature. Only a very few perithecia are sufficiently mature to show any apical branching at all of the appendages. Figs. 56 and 57 show the apex of the most developed appendages seen, but it is very possible that the form here represented is not that of the fully mature apex. It would be hardly

wise, therefore, to express any opinion as to the position of the species.

Eriksson (119) gives the following account of the damage caused by *M. ferruginea* to cultivated plants of *Verbena hybrida*. "So sind seil mehreren Jahren zu Rosendal alle Freilandgruppen von *Verbena hybrida* stark mehlthaukrank gewesen. Dieser Mehlthau sucht aufangs hauptsächlich die Unterseite der Blätter heim, die ein bleichrostfarbiges Aussehen mit hier und da eingestreuten Staubgruppen von derselben Farbe bekommen, bis endlich das Blatt ganz eingesponnen ist. Die Pflanze hat jetzt eben so wie andere mehlthaukranke Pflanzen ein mehr oder weinger weisses Aussehen ausgenommen. . . . Da die Krankheit trotz reichlichem Schwefeln fortdauert, so hat man sich schliesslich genöthigt gefunden, mit der Cultur der Verbenen, wenigstens der älteren, durch Stecklinge vermehrten Varietäten fast gänzlich aufzuhören . . . Bei Rosendal hat man in den letzten Jahren aus Samen, die un Frühjahre ausgesäet waren, kräftigere und dem Mehlthaue weinger ausgesetzte Exemplare gezogen."

13. M. Bäumleri P. Magn. [Figs. 52–55]

P. Bäumleri P. Magn. Bericht. Deutsch. Botan. Gesell. **17**: 148. *pl. 9. f. 17–18.* 1899.

M. Marchica P. Magn. Bericht. Deutsch. Botan. Gesell. **17**: 149. *pl. 9. f. 19.* 1899.

Exsicc.: Rehm. Ascom. 249 sub *Erysiphe Martii.*

Hypophyllous (very rarely amphigenous); mycelium subpersistent or evanescent; perithecia more or less densely gregarious in floccose patches covering the surface of the leaf, globose-depressed, becoming hemispherical, 80–150 μ in diameter; appendages 8–20, usually 8–14, 4–6 times the diameter of the perithecium, flaccid, penicillate when mature, smooth or slightly rough, colorless, thick-walled at base, apex about 3 times dichotomously branched when mature, branching vague and lax, branches of the higher orders more or less irregularly placed, tips of the ultimate branches not recurved; asci 4–12, ovate to oblong, usually shortly stalked, 55–70 × 30–38 μ; spores 4–6 (8 recorded by Magnus), 20–22 × 10–12 μ.

Hosts.—*Vicia cassubica*, *V. sylvatica.*

Distribution.—Europe: Britain (Scotland), Italy, Austria-Hungary, Germany, Russia.

When working through the material of the Erysiphaceae in the Kew Herbarium at the end of last year, I noticed certain specimens named "*Erysiphe communis*" in Berkeley's herbarium (on *Vicia sylvatica*, from Scotland), and others named "*E. Martii*," in Rehm's Ascomyc., n. 249 (on *V. cassubica*, from Franken), which clearly belonged to the genus *Microsphaera*. This was also the case with specimens sent as "*E. Martii*," about the same time, by Professor Massalongo from Italy, and with Russian specimens, named "*E. astragali?*" in Professor Tranzschel's Russian herbarium—both on *V. sylvatica*.

These specimens showed the apex of the appendages about three times dichotomously branched, with the branching vague and irregular. A very slow development of the apical branching was evidently characteristic of the plant, and the appendages in this and other characters closely resembled those of *M. astragali*, to which species I had intended referring the plant as a new variety, differing from the type in the more branched apex of the appendages.

Magnus (231) has since described the plant on *Vicia sylvatica*, (from Hungary), as a new species, *Microsphaera Bäumleri*, and has at the same time published another species, *M. Marchica*, on *V. cassubica*.

M. Bäumleri is described as follows: "Sie hat schöne lange Appendiculae, die an den Enden ein bis vier Mal dichotom getheilt sind. Die letzten Verzweigungen der Appendiculae sind stets ziemlich lang und stets gerade vorgestreckt, vorne stumpf abgerundet ohne jede Spur einer Krümmung. . . Sie ist durch die ziemlich langen, wenig divergirenden, gerade vorgestreckten, vorn stumpf abgerundeten Enden der letzten Gabelungen der Appendiculae vor den anderen in der alten Welt auf Papilionaceen auftretenden Microsphaeren recht ausgezeichnet. Auch bei ihr kommen zuweilen unverzweigte Appendiculae vor. Der Durchmesser der Perithecien is durchschnittlich 120 μ. Der Ascus enthält meist 8 Sporen. Die Ascosporen sind 18 μ lang und 10 μ breit. Sie schliesst sich der *M. diffusa* C. et P. an."

M. marchica is thus described: "Die Perithecien sind 110–130 μ breit. . . . Die Appendiculae entspringen von der oberen Hälfte des kugeligen Apotheciums und richten sich meist

schopfartig auf, wie bei *M. astragali.* Sie sind meist einfach, nur selten an der Spitze zweitheilig oder zweimal zweitheilig. Sie sind etwa vier—bis sechsmal so lang als das Perithecium. . . . Die Appendiculae sind an den Enden breit abgerundet stumpf. . . . Auch schliesst sie sich verwandtschaftlich der *M. coluteae* Kom. und *M. Bäumleri* P. Magn. nahe an."

Professor Magnus has very kindly sent me specimens (now in the Kew Herbarium) of *M. Mäumleri* and *M. Barchica. M. Bäumleri* shows the characters as given in my description above.

M. Marchica I consider is founded on an immature stage of the same species. In Magnus' figure (231, *f. 19*) the appendages are represented as unbranched, and in the diagnosis are said to be "meist einfach, nur selten an der Spitze zweitheilig oder zweimal zweitheilig." The specimens sent by Professor Magnus (which agree with the description given) are certainly too immature to show the nature of the final branching of the apex. The appendages in these specimens are either undivided at the apex, or have begun to fork once or twice. The specimens on the same host (*Vicia cassubica*) in Rehm's Ascomyc. n. 249, which certainly represents the same plant, is much more mature, and the appendages here show so close a resemblance in their branching to that of *M. Bäumleri*, and the habit of the two plants are so similar, that I feel bound to consider them as belonging to one species.

The other plant on *Vicia sylvatica* mentioned by Professor Magnus (231, p. 148), of which specimens were sent, I consider also to be *M. Bäumleri* in an immature condition.

The affinity of *M. Bäumleri* is certainly with *M. astragali. M. diffusa*, to which the present species has been compared, differs widely in the shorter, non-penicillate appendages, more branched apex of the appendages, etc. In *M. astragali* the appendages are usually unbranched, sometimes once forked, or rarely twice dichotomous. I have once, however, seen a specimen in which the apex showed signs of becoming 3 times dichotomously branched. (Fig. 47). How far the usually unbranched condition of the appendages of *M. astragali* is to be considered as the result merely of immaturity, remains at present doubtful; it is possible that further investigations of fully mature specimens may prove that the apex becomes branched regularly in age, and even that *M. Bäumleri* should be united with *M. astragali.*

M. euonymi, also, is related to the present species in the penicillate (though usually shorter) appendages, but differs in the closer and more elaborate branching of the appendages.

M. Bäumleri has hitherto been recorded only from Germany and Austria, but specimens from the following countries belong here: Scotland, New Pitsligo (specimen in Herb. Berkeley at Kew); Italy, Verona (Massalongo, Sept., 1887); Russia, Bologov, prov. Novgorod (Tranzschel, Aug., 1897).

ERYSIPHE Hedw. f.; DC. (emend. Lév.) Ann. sci. nat. III. 15: 161. 1851

Perithecia globose, or globose-depressed, sometimes becoming concave; asci several, 2–8-spored. Appendages floccose, simple or irregularly branched (never with a definite apical branching), sometimes obsolete, usually more or less similar to the mycelium and interwoven with it, very rarely (*E. tortilis*) brown, assurgent and fasciculate. Etym. ερυσιβη, *robigo*.

Distribution.—Europe, Africa, Asia, Australia, New Zealand, North America—8 species and 1 variety.

The genus is characterized by the floccose appendages (sometimes obsolete or apparently absent), simple or vaguely branched, more or less similar to the hyphae of the mycelium, and frequently interwoven with them. *Sphaerotheca* is distinguished by the single ascus. *E. tortilis* has a habit approaching that of some species of *Microsphaera*—a genus connected on its side with *Erysiphe* through *M. astragali*.

Key to the Species of Erysiphe

1. Asci (of mature perithecia) not containing spores on the living host-plant. 2.
   Asci (of mature perithecia) containing spores. 4

2. Perithecia large, 135–280 μ in diameter, averaging 200 μ, more or less immersed in the lanuginose persistent mycelium. 4. *graminis*.
   Perithecia smaller, 80–140 μ, not immersed in a lanuginose mycelium. 3.

3. Haustoria lobed. 3. *galeopsidis*.
   Haustoria not lobed. 2. *cichoracearum*.

4. Asci 2-spored, rarely (and never uniformly) 3-spored. 5.
   Asci 3–8-spored, rarely (and never uniformly) 2-spored. 8.

5. Perithecia 52–60 μ in diam.; asci 3, 48–50 $\times$ 28–36 μ. 8. *trina*.
   Perithecia 80–240 μ in diam.; asci more than 3, larger. 6.

6. Perithecia large, becoming pezizoid, 135–240 μ in diameter, usually about 200 μ; asci 7–38, usually about 20, 75–110 μ long, averaging 90 μ, spores 28–40 μ long, averaging 32 $\times$ 18 μ long. 6. *taurica*.

Perithecia 80–140 μ (very rarely 100–175); asci 4–25 (very rarely as many as 36). usually 10–15, 58–90 μ long; spores 20–28 μ long, averaging $34 \times 14\ \mu$. 7.

7. Haustoria lobed. 3. *galeopsidis.*
Haustoria not lobed. 2. *cichoracearum.*

8. Perithecia 65-180 μ in diameter, usually about 90 μ; asci usually few, 2–8, rarely as many as 22, 46–72 (rarely 80) μ long. 9.
Perithecia larger, 130-280 μ in diameter, averaging 180–200 μ; asci 9–42, 70–115 μ long. 10.

9. Appendages very long, 10–20 times the diameter of the perithecium, assurgent and fasciculate. 5. *tortilis.*
Appendages long or short, spreading horizontally, often interwoven with the mycelium. 1. *polygoni.*

10. Perithecia more or less immersed in the lanuginose persistent mycelium. 4. *graminis.*
Perithecia not immersed in a lanuginose persistent mycelium. 11.

11. Spores 4–6, $20–22 \times 10–12\ \mu$. 1. *polygoni*, var. *sepulta.*
Spores 8, rarely 6 or 7, somewhat roundish, $16–20 \times 10–15\ \mu$. 7. *aggregata.*

1. ERYSIPHE POLYGONI DC. [Figs. 132–139, 143, 155, 158]

Mucor Erysiphe Linn. Syst. Veg. 825 (partim). 1774.

Sclerotium Erysiphe Pers. Obs. Myc. **1** : 13 (partim). 1796; Pers. Syn. Meth. Fung. 124 (partim). 1801.

S. Erysiphe, var. *herbarum* Alb. & Schwein. Consp. Fung. Lusat. 76. 1805.

Erysiphe polygoni DC. Fl. Fr. **2** : 273. 1805.

E. convolvuli DC. Fl. Fr. **2** : 274. 1805.

E. pisi DC. Fl. Fr. **2** : 274. 1805; Grev. Scot. Crypt. Fl. **3** : *pl. 134.* 1825.

E. heraclei DC. Syn. Pl. Fl. Gall. 57. 1806.

E. aquilegiae DC. Fl. Fr. **6** : 105. 1815.

E. scandicis DC. Fl. Fr. **6** : 107. 1815.

E. varium Fr. Obs. Myc. **1** : 206 (partim). 1815; and **2** : 366. 1818.

Erysibe pycnopus Mart. Fl. Crypt. Erlang. 329. 1817.

E. macropus Mart. Fl. Crypt. Erlang. 329. 1817.

Alphitomorpha communis Wallr. Berl. Ges. Nat. Freund. Verh. **1** : 31 (excl. vars. *graminearum*, *labiatarum*, *cichoracearum*). 1819; Wallr. Fl. Crypt. Germ. **2** : 758 (partim). 1833.

A. urticae Wallr. Ann. Wett. Ges. **4** : 238. 1819.

A. trifoliorum Wallr. Ann. Wett. Ges. **4** : 238. 1819.

A. hyperici Wallr. Ann. Wett. Ges. **4** : 239. 1819.

A. heraclei Wallr. Ann. Wett. Ges. **4**: 240. 1819.

A. pisi Wallr. Ann. Wett. Ges. **4**: 241. 1819.

Erysibe polygoni DC.; Gray, Nat. Arr. Brit. Pl. **1**: 589. 1821; Schroet. Cohn's Krypt. Fl. Schles. **3**: 234. 1893.

E. pisi DC.; Gray, Nat. Arr. Brit. Pl. **1**: 589. 1821; Schroet. Cohn's Krypt. Fl. Schles. **3**: 236. 1893.

E. convolvuli DC.; Gray, Nat. Arr. Brit. Pl. **1**: 589. 1821.

Erysibe communis Fic. & Schub. Fl. Gegend. Dresd. **2**: 304. 1823; Lk. Willd. Sp. Pl. **6**: 105 (excl. vars. *graminum*, *labiatarum*, *cichoracearum*). 1824; Rabenh. Deutschl. Crypt. Fl. **1**: 232 (partim). 1844.

Erysiphe trifolii Grev. Fl. Edin. 459. 1824.

E. lathyri Grev. Fl. Edin. 460. 1824.

E. robiniae Grev. Fl. Edin. 460. 1824.

E. asperifoliorum Grev. Fl. Edin. 461 (partim). 1824.

E. ranunculi Grev. Fl. Edin. 461. 1824.

[?] *Erysibe epimischa* (*Physalis*) Lk.; Willd. Sp. Pl. **6**: 110. 1824.

Erysiphe communis Grev. Scot. Crypt. Fl. Synops. 9. 1828; Fr. Syst. Myc. **3**: 239 (partim). 1829; Duby, Bot. Gall. **2**: 869 (excl. vars. *graminum*, *labiatarum*, *cichoracearum*. 1830; Berk.; Sm. Engl. Fl. 5, pt. 2, 325 (partim). 1836; Dur. & Mont. Fl. d'Algér. (Crypt.) 565 (excl. var *graminis*). 1846–9; Lév. Ann. sci. nat. **15**: 171. *pl. 11. f. 38.* 1851; Tul. Sel. Fung. Carp. **1**: 214. 1861; Cooke, Micr. Fung, 221. *pl. 12. f. 240–242.* 1865; de Bary, Beitr. Morph. Phys. Pilz. **1**: §xiii. 50. 1870; Cooke, Handb. Brit. Fung. **2**: 652. 1871; Karst. Myc. Fenn. 194. 1873; Sacc. Syll. Fung. **1**: 18. 1882; Witn.; Rabenh. Krypt. Fl. Deutschl. $\mathbf{1}^2$: 32. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 93. 1885; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 402. 1887; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 64. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 10. 1892; Jacz. Bull. l'Herb. Boiss. **4**: 731. 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 97. 1897.

Perisporium erysiphoides Fr. Syst. Myc. **3**: 251. 1829.

Erysiphe daphnes Duby, Bot. Gall. **2**: 870. 1830.

Alphitomorpha nitida Wallr. Fl. Crypt. Germ. **2**: 757. 1833.

Erysiphe liriodendri Schwein. Syn. Fung. Am. Bor. 269.

1834; Sacc. Syll. Fung. **1**: 21. 1882; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 401. 1887; Burr.; Ell. & Everh. N. Amer. Pyren. 10. 1892.

Erysiphe macularis Kickx. Fl. Crypt. Env. Louv. 138 (partim). 1835.

E. Perisporium Cord. Icon. Fung. **2**: 28. *pl. 13. f. 99.* 1838.

Erysibe nitida (*delphinii*) Rabenh. Deutschl. Krypt. Fl. **1**: 231. 1844.

Erysiphe convolvuli sepii Cast. Cat. Pl. Mars. 188. 1845.

E. ranunculi Cast. Cat. Pl. Mars. 189. 1845.

E. polygoni Cast. Cat. Pl. Mars. 189. 1845.

Erysibe ulmariae Desmaz. Ann. sci. nat. III. **6**: 66. 1846; Desmaz. Fl. Crypt. Fr. ser. 1, n. 1515. 1846; *Desmaz. Mém. Soc. Roy. Sci. Lille for 1846: 141. 1847; Desmaz. Ann. sci. nat. II. **8**: 14. 1847.

Erysiphe Martii Lév. Ann. sci. nat. III. **15**: 166. *pl. 10. f. 34* (syn. excl. partim). 1851; Cooke, Micr. Fung. 220. *pl. 11. f. 237–239.* 1865; Cooke, Handb. Brit. Fung. **2**: 651. 1871; Karst. Myc. Fenn. **2**: 193. 1873; Sacc. Syll. Fung. **1**: 19. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. $\mathbf{1}^2$: 31. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 93. 1885; Jacz. Bull. l'Herb. Boiss. **4**: 728. 1896. Oudem. Rév. Champ. Pay.-Bas. **2**: 97. 1897.

E. densa Berk. Hook. Fl. Nov. Zeal. **2**: 208. *pl. 105. f. 16.* 1855; Hook. Handb. New Zeal. Fl. 637. 1867; Sacc. Syll. Fung. **1**: 18. 1882.

E. ulmariae Desmaz.; Kickx. Fl. Crypt. Fland. **1**: 381. 1867; Sacc. Syll. Fung. **1**: 19. 1882; Oudem. Rév. Champ. Pays.-Bas. **2**: 99. 1897.

E. umbelliferarum de Bary, Beitr. Morph. Phys. Pilz. **1**: § xiii. 50. 1870; Sacc. Syll. Fung. **1**: 17. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. $\mathbf{1}^2$: 31. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 93. 1885; Oudem. Rév. Champ. Pays.-Bas. **2**: 96. 1897.

E. vernalis Karst. Myc. Fenn. **2**: 193. 1873; Karst. Helsing. Faun. Fl. Fenn. Notis. **13**: 247. 1874; Sacc. Syll. Fung. **1**: 19. 1882; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 93. 1885.

E. Martii Lév. f. *acaciae* Erikss. Bid. Känned. våra odlade växt. sjuk. 51. 1885.

Erysibe heraclei DC.; Schroet.; Cohn's Krypt. Fl. Schles. **3**: 239. 1893.

Erysiphe communis, var. *umbelliferarum* (de Bary) Jacz. Bull. l'Herb. Boiss. **4**: 733. 1896; Jacz.-Kom.-Tranz. Fung. Ross. Exsicc. no. 130 (cum diag.). 1896.

E. communis, var. *ulmariae* Jacz. Bull. l'Herb. Boiss. **4**: 734. 1896.

Microsphaera caraganae Magn. Bericht. Deutsch. Bot. Gesellsch. **17**: 150. *pl. 9. f. 1–4.* 1899.

Erysiphopsis parnassiae Halsted, Bull. Torr. Club, **26**: 594. 1899.

EXSICC.: Bri. e Cav. Fung. par. 173; Rab. Fung. Eur. 31, 562, 563, 564, 1057, 1060, 1061, 1062, 1063, 1064, 1065, 1068, 1069, 1426, 1431, 1522, 1736, 1918, 2027, 2134, 2415, 2521; Syd. Myc. March. 198, 338, 653, 659, 838, 839, 980, 981, 1077, 1142, 1143, 1198, 1240, 1638, 2222, 2328, 2658, 2659, 2765, *3669, *3671, *3718, *3822, *3914, *3915, *3916, *3917, *4241, and 432, 655, 1541, 1640, 3052 sub *Sphaerotheca Castagnei;* Fckl. Fung. Rhen. 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 671, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 1738, 1742, 1743, 1744, 2237 and 432, 1541, 3052, sub *Sphaerotheca Castagnei;* Rab. Herb. Myc. ed. 2, 462, 466, 467, *476, 477, 479, *480, 482, 483, *486, 670; Roumeg. Fung. Gall. Exsicc. 1376, 1379, 1534, 1539, 1983, 2072, 2074, 2373, 2450, 2556, 2557, 3226, 3646, 3741, 4565, and 3645, sub *E. lamprocarpa;* Desmaz. Pl. Crypt. Fr. ser. 1, 166, 264, 265, 459, 1108, 1304 (B only), 1515, 1518, 2197, 2198; ser. 2, 671, 672; *ed. 2, ser. 1, 109, 508 (A only), 813, 1015, 1018, 1847, 1848; Jacz.-Kom.-Tranz. Fung. Ross. Exsicc. 130; de Thuem. Fung. exot. dec. 12, sub *E. lamprocarpa;* de Thuem. Fung. austr. 143, 144, 145, 146, 239, 240, 241, 447, 448, 449, 453, 454, 455, 458, 651, 652, 857, 955, *1044, 1141, 1143, 1240, 1241, 1242, 1243 and 457 sub *E. horridula;* and 1237 sub *Microsphaera astragali;* Sacc. Myc. Ven. 68, 149, 150, 151, 602, 603, 604, 605, 609, 610, 695, 786, 787, 896, 897, 898, 1170; Rehm. Ascom. 350, 398, 399, 449, 500, 546, 547, 650, 799, 800; Fries, Scleromyc. Suaec. 69; Cooke, Fung. Brit. Exsicc. 96, 99; ed. 2, 288, 593, 594, 600; Vize. Fung. Brit. 95, 98; Westend. Herb. Crypt. Belg. 120, 408, 553 (e only), 737, 830, 1389; de Thuem. Myc. univ. 156, *449, 1449, 1937, 2057; Karst

Fung. Fenn. Exsicc. 280, 368, 784; *Wartm. & Schenk, Schweiz. Krypt. 524, 525, 629; Wahrlich. Parasit. Pilz. 28, 29 (in Herb. Hort. Imp. Petropol.); *Funck, Crypt. Gew. Fichtelgeb. 384; *Erikss. Fung. par. scand. 38a, 38b, 148a, 236, 237, 340; *Schmidt & Kunz. Deutschl. Schw. ccxxii.; Seym. & Earle, Econ. Fung. 252; *Kneiff. & Hartm. Fl. Crypt. Bad. 159; *Krieg. Fung. Saxon. 71, 822, 823, 824, 825, 827, 828, 829, 830, 831; *Gandog. Fl. Alger. exsicc. 1980, 1983; *Ell. & Everh. Fung. Columb. 614; *Cav. Fung. Long. exsicc. 118; Oudem. Fung. Neerl. Exsicc. 73, 74, 155, 156, 157, 158; Zopf & Syd. Myc. March. 52; Jack, Lein. & Stizenb. Krypt. Bad. 631, 632; Speg. Dec. Myc. Ital. 84, 84bis; Klotzsch, Herb. Myc. 61; and 65 sub *E. urticae;* and 1743, 1744 (Herb. Mus. Florence); Berk. Brit. Fung. 200, 201, 203, 269; Baxt. Stirp. Crypt. Oxon. fasc. 2, 97; Rab.-Wint. Fung. Eur. 3243; Kunze, Fung. select. exsicc. 60; Erbar. Critt. Ital. ser. 1, 192 (in Herb. Mus. Florence); Linhart, Fung. hungar. 457 (in Iowa State College Herb.); Ell. & Everh. N. Amer. Fung. 835, 2112, sec. ser. 3103.

Amphigenous; mycelium very variable, persistent, thin, effused and arachnoid or rarely thick, dense and lichenoid, or more often completely evanescent; perithecia gregarious to scattered, rarely densely gregarious, usually rather small, about 90 μ, but varying from 65–180 μ in diameter, cells usually distinct, 10–15 μ wide, rarely 20 μ wide; appendages very variable in number and length, sometimes few (3–7), distinct and long (10 times or more the diameter of the perithecium), or more rarely few and short, usually numerous and crowded, more or less densely interwoven, and long or short, always spreading horizontally, often interwoven with the mycelium, simple or rarely much branched, and then widely and irregularly forking, sometimes angularly bent, or flexuose-contorted, colored dark or pale brown at the base or throughout, or quite colorless, rarely becoming shining white, septate when colored; asci usually few, 2–8, rarely as many as 22, variable in shape and size, usually small and ovate, but varying from ovate to broadly ovate or subglobose, with or without a short stalk, 46–72 (very rarely reaching to 80 μ) × 30–45 μ; spores 3–8, usually 3–6, very rarely (and never uniformly), only 2, 19–25 × 9–14 μ.

Hosts.—Achillea Ptarmica (350), *Aconitum Anthora* (341), *A. Fischeri, A. Napellus, A. paniculatum* (176), *Actaea spicata, Adonis vernalis* (22), *Aegopodium Podograria* (176) (230) (390), *Aethusa Cynapium, Ajuga reptans* (353), *Albizzia lophantha, Alnus incana,*

Alyssum calycinum, *A. campestre* (272), *Amelanchier alnifolia* (200), *A. maculatum* (6), *Amphicarpaea Edgeworthii*, var. *Japonica*, *A. monoica*, *Anchusa officinalis*, *Anemone dichotoma*, *A. ranunculoides* (108), *A. thalictroides* (280), *A. Virginiana*, *Angelica sylvestris*, *Anthriscus Cerefolium*, *A. sylvestris*, *Antirrhinum Orontium* (230), *Aquilegia Canadensis*, *A. vulgaris*, *Arabis Turrita* (230), *Archangelica officinalis*, *Arenaria decipiens*, *A. juniperina* (389), *Aristotelia racemosa*, *Asperula odorata* (3), *Aster commutatus* (119), *Astragalus adsurgens*, *A. baeticus*, *A. caespitosus*, *A. Canadensis*, *A. caryocarpus* (60), *A. decumbens* (6), *A. frigidus*, var. *Americanus*, *A. Gebleri*, *A. glycyphyllosus* (359) (390), *A. hypoglottis* (6), *A. junceus* (363), *A. Lamberti*, *A. multiflorus* (6), *A. oroboides* and var. *Americanus*, *A. reflexistipulus*, *A. triphyllus* (7) (60), *A. virgatus*, *Baptisia tinctoria*, *Brassica Rapa*, *B. Sinapistrum* (56) (271), *B. sinapoides* (214), *Breynia acuminata*, *Calendula arvensis* (55), *C. officinalis* (22) (209), *Caltha palustris*, *Calystegia sepium*, *Campanula rapunculoides*, *Capsella Bursa-pastoris*, *Caragana arborescens*, *Carduus* sp., *Carum Persicum* (233), *Cassia Chamaecrista* (361), *Catalpa syringaefolia*, *Caucalis Japonica*, *Centaurea scabiosa* (364), *Chaerophyllum aromaticum*, *C. aureum*, *C. bulbosum* (345) (383), *C. hirsutum*, *C. nodosum* (383), *C. temulum*, *C. Villarsii* (230), *Chelone glabra* (122), *Cicuta virosa* (319), *Cimicifuga foetida* (347), *Circaea Lutetiana*, *Clematis alpina*, and var. *Sibirica* (341), *C. Flammula* (cult.), *C. fusca*, var. *yezoeüsis*, *C. integrifolia* (319), *C. leucantha* (319), *C. ligusticifolia* (363), *C. recta*, *C. Virginiana*, *C. Vitalba*, *Cnicus lanceolatus*, *Colutea arborescens*, *Conium maculatum* (285) (319), *Convolvulus Ammannii*, *C. arvensis*, *C. sagittatus*, *Coronilla Emerus* (285), *C. varia* (230), *Crambe Sewerzowi* (206), *Cucumis sativus* (230), *Cucurbita* (39), *C. Pepo* (230) (319), *Cuphea viscossissima*, *Cytisus purpureus* (378), *Dahlia* (cult.) (363), *Daphne alpina*, *Daucus grandiflorus*, *Delphinium Ajacis*, *D. azureum* (263), *D. Consolida*, *D. elatum*, *D. formosum*, *D. grandiflorum* (288), *D. orientale*, *D. tiroliense* (230), *D. vestitum*, *Desmanthus brachylobus* (cult.), *Diervilla Japonica*, *Diplotaxis tenuifolia* (214), *Dipsacus laciniata*, *D. sylvestris* (56) (133) (319), *Draba hirta* (60), *Echium vulgare*, *Elsholtzia cristata*, *Erectites praealta* (35), *Eryngium macrocalyx*, *Erysimum cheiranthoides* (107), *E. odoratum* (353), *Fagopyrum esculentum*, *Falcaria vulgaris*, *Falcata comosa* (386),

Galium (35) (394), *G. Aparine* (3) (56) (107) (133) (205*) (230) (263) (290) (319), *G. boreale* (206) (359), *G. Mollugo* (133), *G. sylvaticum* (3) (205*) (290) (391), *Geranium dissectum* (3), *G. maculatum*, *G. molle* (263), *G. pratense* (107) (132) (133) (345), *G. pusillum* (345), *G. pyrenaicum* (214), *G. Richardsoni* (60) (199), *G. sylvaticum* (290), *G. tuberosum* (206), *Geum urbanum*, *Gutierrezia Euthamiae* (199), *Gypsophila Gmelini*, *Heracleum asperum* (cult.), *H. flavescens* (345), *H. palmatum*, *H. Sibiricum*, *H. Sphondylium*, *Hesperis matronalis*, *H. tristis* (22), *Heuchera Americana* (157*), *Hosackia parviflora*, *Hyoscyamus niger* (347), *Hypericum atomarium*, *H. hirsutum*, *H. montanum*, *H. perforatum*, *H. quadrangulum*, *Inula salicina* (22) (348), *Isatis tinctoria* (50), *Johrenia* sp., *Lactuca muralis* (3), *Lithospermum arvense* (3), *Lathyrus Aphaca*, *L. montanus* (115) (133) (311), *L. Nessolia* (263), *L. pisiformis*, *L. polymorphus* (363), *L. polyphyllus*, *L. pratensis*, *L. tuberosus*, *L. uliginosus*, *L. venosus*, *Lespedeza striata* (151), *Linaria genistifolia* (22), *Liriodendron Tulipifera*, *Lotus corniculatus* (383 and 384), *L. major*, *L. Purshiana*, *Lunaria rediviva* (290), *Lupinus albus*, *L. angustifolius* (319), *L. argenteus* var. *argophyllus* (363), *L. laxiflorus*, *L. luteus*, *L. parviflorus*, *L. perennis*, *L. sericeus*, *Lychnis alba* (319) (344), *L. dioica*, *L. sylvestris* (22), *Lycopersicum esculentum* (342), *Lycopsis arvensis*, *Lythrum Salicaria*, *Malcomia maritima* (56), *Medicago falcata*, *M. lupulina*, *M. sativa*, *Melilotus alba*, *M. officinalis*, *Myrrhis odorata*, *Oenothera albicaulis*, *O. biennis*, *O. sinuata* (12) (60), *Onobrychis viciaefolia* (22) (56) (230) (290), *Ononis arvensis*, *O. hircina* (319), *O. spinosa*, *Orobus Lathyroides*, *Oxytropis Lamberti*, *Paeonia obovata*, *P. officinalis*, *P. peregrina*, *Parnassia Caroliniana*, *Pedicularis resupinata* (309), *Peucedanum alsaticum* (22), *P. Cervaria* (22) (377), *P. oreoselinum*, *P. sativum*, *P. terebinthaceum*, *Phaseolus helvolus* (363), *P. perennis* (60), *Phloiodocarpus dahuricus*, *Physospermum commutatum*, *Picris hieracioides* (347), *Pilea stipulosa*, *Pimpinella magna*, *P. Saxifraga*, *Pisum sativum*, *Polygonum aviculare*, *P. dumetorum*, *P. lapathifolium*, *P. Persicaria* (66), *P. ramosissimum*, and var. *prolificum* (151), *Potentilla* (176), *Prenanthes purpurea* (133) (290), *Psoralea tenuiflora* (60) (151), *Quercus glauca*, *Ranunculus abortivus*, *R. aconitifolius* (290) (319) (364), *R. acris*, *R. arvensis*, *R. Asiaticus* (354), *R. bulbosus*, *R. Cymbalaria*, *R. Flammula*, *R. lanuginosus*

(176) (319), *R. Lingua* (318), *R. macranthus* (6), *R. montanus*, *R. multifidus*, *R. Pennsylvanicus*, *R. repens*, *R. sardous*, *R. sceleratus* (6) (199), *R. septentrionalis* (60), *R. trachycarpus*, *Robinia Pseuda-cacia* (95) (319), *R. viscosa*, *Rumex Acetosella*, *R. Hydrolapathum* (318), *Saxifraga cortusaefolia*, *Scabiosa arvensis*, *S. stellata* (50), *S. Succisa* (107), *S. sylvatica*, *Scandix Pecten-Veneris*, *Scutellaria lateriflora* (35) (386), *S. scordiifolia*, *Selinum carvifolia*, *Sselie* (349), *S. Libanotis* (164*), *Silaus flavescens* (319), *Silene noctiflora* (22), *Siler trilobum* (391), *Sisymbrium alliaria* (22), *S. officinale* (56), *S. Sophia*, *Sium erectum*, *S. latifolium* (319), *Smyrnium olusatrum* (18), *Sonchus* (172), *S. arvensis* (22), *Spartium junceum* (272), *Spiraea ulmaria*, *Statice Gmelini*, *S. Limonium*, *Symphytum officinale* (3), *Teucrium Chamaedrys* (20), *Thalictrum angustifolium* (319), *T. aquilegifolium*, *T. Cornuti*, *T. flavum*, *T. minus* and var. *elatum*, *T. simplex*, *Thermopsis montana*, *Thesium Bavaricum* (378), *T. ebracteatum* (107), *Thlaspi arvense* (310), *Tragopogon* (301), *Trifolium agrarium* (290) (319) (384), *T. alpestre*, *T. arvense*, *T. filiforme*, *T. hybridum*, *T. incarnatum*, *T. involucratum*, *T. longipes*, *T. Lupinaster*, *T. medium*, *T. minus*, *T. monanthum* (60), *T. montanum*, *T. moranthum*, *T. pauciflorum*, *T. pratense*, *T. procumbens*, *T. repens* (18) (290) (319), *T. rubens*, *Trigonella cretica*, *T. Foenum-graecum*, *Trollius Europaeus*, *Urtica cannabina*, *U. dioica*, *U. urens* (263), *Valeriana capitata* (206), *V. officinalis* (22) (107) (132) (133) (192) (230) (319), *Valerianella dentata* (319), *V. rimosa* (73*), *Verbascum phlomoides* (302), *V. Thapsus* (107) (263), *Verbena urticifolia* (35), *Veronica Teucrium* (22), *Vicia Americana* (60) and var. *linearis* (5) (6), *V. cassubica* (319) (359), *V. Cracca*, *V. Faba* (214), *V. gemella* (383), *V. hirsuta* (383), *V. oroboides*, *V. pallida*, *V. sativa* (107) (214) (260) (383) (384), *V. sepium*, *V. sylvatica*, *V. unijuga*, *Vincetoxicum officinale* (22) (344).

Distribution.—EUROPE: Britain, France, Spain, Portugal (260) (355), Belgium, Netherlands, Switzerland, Italy, Germany, Austria-Hungary, Servia (318), Denmark, Norway, Sweden, Finland, Russia.

AFRICA: Algeria, Canaries (253).

ASIA: Turkey (Marash), Cyprus, Transcaucasia (338), Persia (233) (389), Turkestan, Siberia (Minussinsk), Soongaria, India, Japan.

NEW ZEALAND.

AUSTRALIA : Victoria (225).

NORTH AMERICA : United States—Maine, Massachusetts, New York, Pennsylvania, Maryland, New Jersey, Delaware, Virginia, Carolina, Ohio, Michigan, Indiana, Alabama, Illinois, Mississippi, Wisconsin, Missouri, Iowa, Minnesota, South Dakota, Nebraska, Kansas, Montana, Idaho, Wyoming, Colorado, Utah, Nevada, California, Washington ;—Canada, New Brunswick, Ontario, Manitoba.

E. polygoni (*E. communis* and *E. Martii* of most authors) is the commonest and the most variable species of the Erysiphaceae. As may be seen from the specific description given above, the present species is variable in every character ; nature of the mycelium, size of the perithecium, number, length, color, etc., of the appendages, number of asci and spores. It may seem, at first sight, undesirable to allow so wide a range of variation to a single species, yet from the study of a very considerable amount of material it has seemed to me impossible—so closely are the extreme forms linked to the type—to separate any of these forms as varieties, much less as species. As a matter of fact, although several forms here included under *E. polygoni* have been separated as distinct species, *E. polygoni* itself has been frequently confused with *E. cichoracearum*, as a glance at any large herbarium will show. Before attempting to separate and give names to the most striking forms of *E. polygoni*, it seems to me wiser to collect the vast number of forms of the two mildews (recorded as parasitic on no less than 602 species of plants) round the two specific centers here distinguished as *E. polygoni* and *E. cichoracearum*.

Moreover the forms which have been hitherto separated from *E. polygoni* as distinct species are certainly not satisfactorily defined.

E. Martii (*E. pisi*) still appears in many works as distinct from *E. polygoni*, although the name appears practically to be one applied to examples of *E. polygoni* on certain host-plants quite as much as to a form based on any morphological characters. Originally, *E. Martii* was distinguished from "*E. communis*" by Léveillé on the ground of possessing colorless appendages ; De Bary, however, finding that this supposed character did not hold good, united the two, and many subsequent authors followed this

arrangement. Winter (394) and Schroeter (319), however, still keep the two apart as distinct species, although both authors admit that, perhaps, the character of colored or colorless appendages is variable. As a matter of fact, as Burrill (60) has pointed out, many of the specimens in the exsiccati quoted by Winter as belonging to *E. Martii* have distinctly colored appendages. An examination of specimens named *E. Martii* in herbaria shows at once that in the forms of the present species, no satisfactory systematic character exists in the absence or presence of color in the appendages, as a complete series of connecting links occurs, often, even in specimens on the same plant, as may be seen in some examples on *Lupinus*. In many cases, though not in all, the absence of color is dependent merely on the age of the specimen as at full maturity colorless appendages frequently become dark brown. *E. Martii*, therefore, I think, may be safely considered a synonym of the present species.

Oudemans (263) has attempted to separate certain forms of *E. polygoni* by the number of spores in the ascus: *E. umbelliferarum* on plants belonging to the Umbelliferae (*e. g.*, *Anthriscus*, *Heracleum*) is stated to have 3–4 spores; *E. communis* and *E. Martii* (on *Polygonum*, *Hypericum*, etc.), 4–8 spores. These characters, however, altogether fail, and it need only be mentioned that on *Hypericum* and *Polygonum* we quite commonly find asci containing only 3 spores, while 3–6 spores occur frequently in specimens on *Heracleum*, etc. It will certainly be admitted by any one dealing with sufficient material of *E. polygoni* that the number of spores varies from 3–8 in this species.

E. umbelliferarum (*E. heraclei*) is generally separated, however, not by the number of spores, but by the shape of the conidia. De Bary first pointed out this character when founding the species, describing the conidia of *E. communis* as "ellipsoidea" and those of *E. umbelliferarum* (on *Angelica*, *Chaerophyllum*, *Anthriscus*, *Pastinaca*, *Falcaria* and *Heracleum*) as "exacte cylindrica"; further remarking "dass diese Art *E. umbelliferarum* von *E. communis* durch die Perithecien kaum verschieden ist. Dagegen ist sie ausgezeichnet durch die Form der Conidien, welche genau walzenförmig, an beiden Enden flach, und mindestens (doch nicht immer) sehr langgestreckt sind. Bei den vorher genannten Arten

allen haben die Conidien die (im Profil elliptische) Gestalt einer schmalen an den Enden abgerundeten Tonne."

Winter, Schroeter, and others, have followed De Bary in maintaining *E. umbelliferarum* as a distinct species, confined to Umbelliferae and distinguishable from *E. polygoni* (*E. communis*) only by the shape of its conidia. I have, however, found generally in studying specimens of *Oidium* in the fresh state that the shape (and size) of the conidium is subject to so much variation that I am strongly inclined to doubt the advisability of employing such characters for systematic purposes, and especially of considering them of specific importance. In the present case, although only examination of living material of the forms on the different host-plants can satisfactorily settle the whole question, it appears to me very doubtful from the study of herbarium material, if the cylindrical form of conidium is exclusively confined to examples on Umbelliferae and whether conidia of both shapes do not occur in the same specimen. Certainly the conidia of *E. polygoni* on some host-plants, *e.g.*, *Clematis alpina*, are more or less cylindrical. No differences are to be found in the perithecial form of fruit of examples on Umbelliferae to those of *E. polygoni* on other hosts.

In dealing with the variation in mycelial characters we come to two very interesting forms, viz, *E. liriodendri* Schwein and *E. densa* Berk.

E. liriodendri is maintained as a species by Burrill (60), who remarks that it " may be identified by its abundant, white mycelium, especially on the young stems."

I have examined many specimens of this form on *Liriodendron*, and have found no characters except the persistent mycelium by which it can be separated from typical *E. polygoni*. When occurring on the stems, *E. liriodendri* has a thin persistent mycelium, but it is to be noted that on the leaves the mycelium is subevanescent, and then the fungus cannot possibly be distinguished from many of the forms of *E. polygoni* on other hosts. Nor can the persistent mycelium on the stem be considered absolutely peculiar to the form on *Liriodendron*; in the herbarium of the Upsala Museum there is a specimen of *E. polygoni* on the stems of *Thalictrum aquilegifolium* in which the mycelium is persistent, and in some places almost pannose in consistency. This specimen

forms a quite similar state to that of *E. liriodendri* and moreover quite commonly on *Thalictrum minus*, *Polygonum aviculare*, etc. *E. polygoni* shows a tendency towards developing a persistent mycelium.

More marked than *E. liriodendri* is a form on *Diervilla Japonica* from Sapporo, Japan (K. Miyabe and N. Hiratsuka) sent to me by Professor Miyabe under the mss. name of *Erysiphe diervillae*, with these notes, " *E. diervillae* ripens its perithecia only in the early spring of the next year. Mycelial layers are formed on the young branches and persistent capsules. Perithecia 120–135 μ, asci 37–45 × 67–86 μ, ascopores (6–7) 11 × 22 μ." This form on *Diervilla* covers the stem and fruit of the host-plant with soft dense patches of persistent mycelium, in which the perithecia are more or less imbedded. Except in these characters, however, the fungus is not different from *E. polygoni*, and it is to be noticed that here and there on the stem, perithecia occur from which the mycelium has almost or quite disappeared, and so are more or less naked as in ordinary *E. polygoni*.

Even more striking is the plant published by Berkeley as *Erysiphe densa*, on *Aristotelia racemosa* from New Zealand. Berkeley remarked : " This differs from *E. Martii* Lév. merely in its thick persistent mycelium, which gives it a very lichenoid appearance, especially when on the upper surface of the leaf." There is a fine series of " *E. densa* " in the Kew Herbarium, and the specimens show in a very clear manner how variable the nature of the mycelium is in the present species, even on the same host-plant. In this series, the mycelium on most of the leaves is very dense and compact, more or less thick, and lichenoid, either limited to spots or extending more or less completely over the whole upper surface of the leaf. The fungus in this condition seems quite distinct from *E. polygoni*, in which a persistent lichenoid mycelium has not been recorded on any host. On other leaves of *Aristotelia* in this series, however, we find only a thin layer of persistent mycelium, from arachnoid to merely pruinose in consistency. Finally, on some leaves we find an absolutely evanescent mycelium. I can find no difference in the perithecia from those of *E. polygoni*, and under the circumstanees, considering the variable nature of the mycelium, I do not think *E.*

densa—although so marked in its extreme state—can be given even a varietal rank. Nothing can be more marked, at first sight, than the forms of *E. taurica* with persistent densely compacted mycelium, yet we find that this species may not uncommonly occur with an evanescent mycelium; in the same way we must, it seems to me, considering the evidence afforded by the forms on *Liriodendron*, *Diervilla* and *Aristotelia*, allow to *E. polygoni* a similar range of variation in mycelial characters.

Karsten, in the second part of Myc. Fenn. has described a species of *Erysiphe* as follows: "*E. vernalis* Karst. Mycelium arachnoideum, saepissime evanidum. Asci in quovis perithecio 8 ovoideo-sphaeroidei, breviter pedicellati 8-spori. Appendiculae sat longae, cum mycelio intertextae. Hab. In ramulis vivis *Alni incanae* fine mensis Maji ad Mustiala semel observata. A sequente [*E. Martii* Lév.] forte non distincta." In the Notiser ur Sällsk. Faun. Fl. Fenn. Förh. **13**: 247 the following further description is given, "Perithecia hemisphaerica, mycelio emersa, fusca, latit. circiter 0.1 mm. Asci 8ni. brevissime pedicellati, ovoidei- vel oblongato-sphaeroidei, longit. circit. 69 mmm., crassit, circit. 39 mmm. Sporae 8nae, sphaeroideo-ellipsoideae, longit. 16–18 mmm., crassit. 11–12 mmm. Appendiculae hyalinae. . . . Species quasi media inter *Erys. graminis* et *Erys. Martii*."

Professor Karsten has kindly sent me specimens (now in the Kew Herbarium) of *E. vernalis*, and after a careful study of the plant and comparison of it with numerous forms of *E. polygoni*, I do not see by what characters it can be separated from this species. It is, nevertheless, a rather marked and extremely interesting form. The fungus occurs on the young shoots of *Alnus incana*; the mycelium is more or less evanescent on the internodes, and the perithecia are here scattered, but at the base of the buds the perithecia become gregarious, and the mycelium is persistent. The perithecia average about 120 μ in diameter, and the appendages are rather long, not much interwoven, hyaline and quite similar in every way to those of many forms of *E. polygoni*. The asci are usually rather numerous, sometimes as many as 15, and may reach to 80 μ in length; in shape they are usually broadly-ovate to ovate-oblong; very rarely, however, they show a tendency to become subcylin-

drical, the 7–8 spores measure about $18 \times 12\ \mu$. Many forms of *E. polygoni* approach so closely to all the above characters (this is the case, *e. g.*, with the form of *Albizzia* (*Acacia*) called by Eriksson *E. Martii* forma *acaciae*) that it seems impossible to separate *E. vernalis* from them. On the other hand, *E. vernalis*, shows undoubted affinity with the American species *E. aggregata* on alder-catkins. *E. vernalis* has smaller perithecia, fewer, smaller, less cylindrical asci, and less interwoven appendages ; occasionally, however, the asci show a tendency to become subcylindrical and the roundish spores are the same in both plants. It is possible that, if more intermediates occur, *E. aggregata* may have to be regarded as only a well marked variaty of *E. polygoni*.

Magnus has considered the fungus growing on *Caragana arborescens* and *Colutea arborescens* as belonging to the genus *Microsphaera*, and has published it as a new species, *M. caraganae*. I had already seen specimens of this plant on *Colutea* in Syd. Myc. March. 980, and on *Caragana* in Syd. Myc. March. 3718, and had referred them to *E. polygoni*. Professor Magnus has kindly sent me very beautiful specimens (now in the Kew Herbarium) of "*Microsphaera caraganae*, on *Caragana arborescens* Wannsee," and after examining these I still feel convinced that the fungus is nothing but a form of *Erysiphe polygoni*. None of the specimens possess appendages with apical branching of the definite type found in *Microsphaera ;* as a rule, the appendages are unbranched, and the branching that does occasionally occur is always quite vague. The appendages are usually about 9 in number, rather distant from one another, septate, and more or less colored towards the base. Occasionally the appendages are as few as four, and the coloring extends almost to the apex. A few perithecia were observed in which the appendages, 4 or 5 in number, were stouter than usual, rounded at the end, and colored deep brown throughout—much recalling the American form of *E. polygoni* on *Parnassia* mentioned below. As Magnus points out, there appear often among the normal appendages very short rudimentary ones. This character, however, as well as that of the few and distant appendages, can be in no way considered peculiar to the form on *Caragana* and *Colutea*, as both are found in many common forms of undoubted *E. polygoni*. In the present form the appendages become more

free from the mycelium than is usually the case, and, as the perithecia are often densely gregarious, give a slightly floccose appearance to the leaf. This habit (which is found in some species of *Microsphaera*), however, is not confined to the plant on *Caragana* and *Colutea*, as in the forms of *E. polygoni* on *Lupinus* (European and American) exactly the same appearance is found.

A very striking form of *E. polygoni* occurs in America on *Parnassia Caroliniana*. I have seen two specimens of this, one from Madison, Wisconsin (Halsted and Tracy, August, 1893), ex herb. S. M. Tracy (in the Herbarium of the Missouri Bot. Garden), where the fungus is labelled "*Erysiphe spatulata*"; the other from Syracuse, New York (L. M. Underwood, July, 1899), named *Erysiphe communis*. The striking feature of this form is the presence of few, brown, usually short, stout, rigid appendages. The perithecia are 70–85 μ in diameter, the asci 3–6, 50–58 $\times$ 30–36 μ, spores 3–5, very rarely 2, 20 $\times$ 10 μ. Except in the appendages, the fungus agrees well with certain common forms of *E. polygoni*. In the Wisconsin specimen the appendages give a very distinct appearance to the form ; they are usually few and very short, in fact often rudimentary and only about a quarter of the diameter of the perithecium in length, very stout (about 10 μ wide), and dark brown throughout ; in the New York specimens, however, most of the perithecia have longer appendages, 3–4 times, or more, the diameter of the appendages, paler towards the apex, and 7–8 μ wide, and it is then at once seen that the present plant is closely connected with many forms of *E. polygoni* on various host-plants, *e. g.*, some specimens on species of *Clematis* and on *Caragana arborescens* are very similar. On the whole, I am inclined to regard the fungus on *Parnassia* rather as a starved form of *E. polygoni*, caused perhaps by growing on an unsuitable host-plant than as a true variety.

(Since the above remarks were written, Halsted (157*) has founded a new genus, *Erysiphopsis*, on this fungus on *Parnassia Caroliniana*. I am quite unable to follow this treatment. Any one at all acquainted with the forms of *Erysiphe polygoni* will, I think, at once admit that the fungus in question clearly belongs to the genus *Erysiphe*, and is, moreover, I believe, so close to certain forms of this species that (as mentioned above) it seems doubtful if it can be separated even as a variety.)

The plant issued as "var. *delphinii*" (on stems of *Delphinium*) Ell. & Everh. N. A. Fung. no. 835 does not differ from many common forms of *E. polygoni*, and cannot be separated from the type.

An interesting *Erysiphe* has been sent to me by Professor Miyabe from Japan (Kyoto, April, 1899, coll. T. Nishida), growing on *Quercus glauca*, which I cannot separate from *E. polygoni*. This form has a rather distinct habit; the persistent, thin, subcrustaceous mycelium forms definite patches on the upper surface of the leaf, and on these the perithecia are more or less gregarious. The diameter of the perithecium is about 90 μ; the asci are 4–6, ovate to ovate-oblong, often without a stalk, $50–58 \times 30–35$ μ, spores 4–6, 21×10 μ. The appendages are from 2 to 3 times the diameter of the perithecium, rather numerous but distinct, colorless, becoming shining, and are more or less irregularly bent, or geniculate, at intervals. Except in the rather marked habit, the fungus does not differ in any way from many common forms of *E. polygoni*. This is the first record of the occurrence of an *Erysiphe* on *Quercus* in the Old World. The Californian *E. trina* on *Quercus agrifolia* is quite distinct from the present form.

The record of *E. Martii* by Cooke (83) on *Populus ciliata* is an error, the fungus being *Uncinula salicis*. The specimens published as *E. Martii* in Rab. Fung. Eur. 1737, on *Rubia peregrina*, and in Roumeg. Fung. Gall. nr. 3316 on *Asperula odorata* are some sphaeriaceous fungus.

E. polygoni is the cause of the disease known as the "blight" or "mildew" of several cultivated plants of economic importance.

In the first place, it causes the "bean" and "pea blight," well known to market gardeners. Bessey (40), speaking of this disease in the United States, says, "pea blight has for many years been very destructive to late peas in the West; it has, in fact, rendered the growth of the later varieties in some instances almost impossible." As regards remedies against the disease, Galloway (135) mentions a case where a crop of beans badly mildewed was "thoroughly dusted with flowers of sulphur, and in a week the fungus had entirely disappeared, and the plants produced a good crop." The following advice is given: "A powder made by mixing equal parts of air-slacked lime and flowers of sulphur

will be found a very good remedy. The powder should be dusted on the foliage at the first appearance of mildew and the operation repeated every ten or twelve days, or more often if there is an abundance of rain. If one has a spraying machine, a solution made by dissolving 3 ounces of carbonate of copper in 2 quarts of aqua ammonia diluted to 22 gallons will be found an efficient remedy. This solution should be applied every twelve or fifteen days, beginning at the first appearance of the disease."

The "mildew of turnips" is also caused by *E. polygoni.* Hitherto the fungus causing this disease has been known only in its conidial stage, and has been wrongly identified as *Oidium Balsamii* (Mont. mss.) Berk. & Broome. Worthington G. Smith (329, p. 76) first gave it this name, and described the disease as follows: "*Oidium Balsamii*, Mont., first attracted attention as a pest of turnips in September, 1880, when Prof. James Buckman, F.L.S., of Bradford Abbas, Dorsetshire, saw the fungus growing in such profusion over hundreds of acres of Swede turnips that the boots and clothes of persons walking through the turnip fields were whitened with the spores. Until 1880 the fungus was not supposed to be common in Britain. . . . Important as this *Oidium* is to agriculturists, no one at present has worked out its life-history, or knows whence it comes, where it goes, what other form it takes, or how it hibernates through the winter. The fungus is more prevalent when a humid September follows on a dry August." Trail (365) notices the disease, and says of "*Oidium Balsamii*," "It is of considerable practical interest, since it attacks various cultivated plants. Near Aberdeen [Scotland] I have seen it in great plenty upon turnips, preferring the Swedish to the common yellow turnip."

In the beginning of November, 1898, my attention was directed to some fields of turnips, near Reigate, Surrey, England, which were, in places, quite white with mildew. On examination it was found that this appearance was caused by the presence of an *Oidium*, which agreed with specimens in the Kew Herbarium named *O. Balsamii*, on turnips, by Worthington G. Smith. *O. Balsamii* (Mont. mss.) is thus described by Berkeley and Broome (38): "Candida, articulis doliiformibus utrinque angustatis. On the leaves of *Verbascum nigrum*, Wothorpe, Aug. 23, 1853. This

species was sent from Milan by Balsamo to Dr. Montagne, under the name of *Oidium Tuckeri*, but it is a very different species, distinguished by the very peculiar shape of its spores. The length about .0015. Balsamo's plant grew on *Verbascum montanum*. No *Erysiphe* has at present been observed in connection with this species. The same species occurs on strawberries, to which it is very destructive. See Gard. Chron., April 15, 1854."

In Berkeley's herbarium at Kew there is the specimen of *O. Balsamii* from Montagne's herbarium referred to above, and the conidia here are more or less barrel-shaped, ranging from 28–30 × 14–18 μ in size (Fig. 161). In the turnip mildew the conidia are subcylindrical, with rounded, unconstricted ends, 30–40 × 13–15 μ, produced singly on the conidiophores (Fig. 162). Probably *O. Balsamii* on species of *Verbascum* is the conidial stage of *Erysiphe cichoracearum* or *E. taurica*; the *Oidium* on strawberries is probably that of *Sphaerotheca humuli*.

After a careful search on the *Oidium*-infected turnips, referred to above, I found on a few plants some scattered patches of the perithecia of *Erysiphe polygoni*. These perithecia occurred chiefly on the stem and petioles, only very rarely on the leaves. The perithecia are mostly gregarious in scattered patches among the subpersistent mycelium and contain about 6 asci, with 4–5 spores. The appendages are colorless, or occasionally one here and there is colored, and are variable in number and length, usually about 2–4 times the diameter of the perithecium. The turnip crop was very poor, but as the plants were infested with "green-fly" (*Aphides*), it is impossible to say to what extent the inquiry was caused by the fungus alone. The remedies given above for the "pea blight" would probably be equally efficacious here.

Var. **sepulta** (Ell. & Everh.). [Fig. 157]

Erysiphe sepulta Ell. & Everh. Bot. Gaz. **14**: 286. 1889.

E. cichoracearum DC. Burr.; Ell. & Everh. N. Amer. Pyren. 12 (form on *Bigelovia graveolens* only). 1892; Jones, Proc. Calif. Acad. Sci. II. **5**: 731. 1895.

Amphigenous; mycelium evanescent or subpersistent; perithecia large, 140–220 μ in diameter, averaging 180 μ, cells indistinct; appendages numerous, rather short, delicate, colorless, hya-

line, densely interwoven; asci very numerous, from 20 to 34, or more, large, broadly ovate-oblong to subcylindrical or subpyriform, 70–100, usually about 85, × 30–36 μ, usually stalked; spores 4–6, 20–22 × 10–12 μ.

Host.—*Bigelovia graveolens* and var. *albicaulis*.

Distribution.—NORTH AMERICA: United States;—Montana, Wyoming, Colorado, Utah (179).

Two forms of *Erysiphe* occur on species of *Bigelovia* (*B. graveolens*) and its var. *albicaulis*, and *B. viscidiflora* (*B. Douglasii*) in the United States. The *Erysiphe* on *B. viscidiflora* has regularly bisporous asci, and although a marked form from its large size must be referred to *E. cichoracearum*, as has already been done by American mycologists. The *Erysiphe* on *B. graveolens* is very different. The perithecia, which occur in scattered patches on the stem, are at first more or less immersed and firmly imbedded in the pannose tomentum of the host-plant; at maturity, however, the perithecia break through the tomentum of the stem, and appear in naked black patches. The perithecia are, as a rule, very large, and contains a great number of asci. The asci are large, rather irregular in shape, sometimes subcylindrical or somewhat pyriform, and contain constantly 4–6 spores, are about 22 × 11 μ in size. These characters give the plant, in my opinion, a position somewhat intermediate between *E. polygoni* and *E. aggregata*; from the former it differs in the larger size, and larger and more numerous asci, from the latter in the more interwoven appendages and 4–6 longer spores. American mycologists have placed this form in *E. cichoracearum*, merely for the reason, it appears that, as mentioned above, on another species of *Bigelovia* (*B. viscidiflora*), *E. cichoracearum*, with its normal bisporous asci, is found. We must remember, however, that many cases occur in which distinct species of the Erysiphaceae are found on even the same species of host-plant, and very commonly we find two or more species of mildew on different species of host-plants belonging to the same genus.

The name *E. sepulta* was published in the Bot. Gazette, **14**: 286. 1889, as follows: "*Erysiphe sepulta* Ell. & Everh. n. sp. This species is so named only provisionally, and may yet prove to be only an old species under peculiar circumstances. . . It comes so near to *E. cichoracearum* that it may well be doubted if it be a new species; but the perithecia appear imbedded in the woolly

coat of the host." Burrill (60), in his description of *E. cichoracearum* says: "Sporidia large, quite uniformly 2, but occasionally varying to 3 or even 4" (on *Bigelovia* 5 or 6), and, under the same species, adds the further remarks. "A form on *Bigelovia graveolens* has 20–30 asci, many of which have 3–5, and perhaps more, sporidia, and the appendages are short and almost hyaline. Taken by itself, it could hardly be admitted as belonging to the present species. Ellis and Everhart provisionally propose the name *E. sepulta* for it. But on *Bigelovia Douglasii*, growing with the preceding, the fungus is in all characteristics the same, except that the sporidia are uniformly 2, in the specimens examined, and so reported by others. The asci are often as many as 30 in both cases, a number much greater than commonly given for typical *E. cichoracearum*. On other host species the number of asci is exceedingly variable, mostly only 4–8, but in some collections east of the Mississippi river reaching 20, with apparently no way of distinguishing different species among the variable forms. Those on *Bigelovia* are indeed further aberrant, but it does not seem wise to separate one or both as specifically distinct, either from each other, or from those with which they are undoubtedly allied on the host-plants enumerated above."

Jones (179), in "*E. cichoracearum*" on *Bigelovia graveolens* from Utah, remarks: "asci numerous, 15–20 or more; sporidia uniformly 4–6, much smaller than in the type. . . The characters given above would suggest a relationship to *E. communis* rather than to *E. cichoracearum*, but no forms of that species have so far been reported on Compositae."

It may, however, be pointed out that, among Compositae, a form of *E. polygoni* occurs on the stem of species of *Carduus* and *Cnicus*, which although very unlike the var. *sepulta* in its small size, yet approaches it in possessing numerous asci (23 or more). The form of *E. polygoni* described as *E. vernalis*, also, must be considered in dealing with the question of the position of the present plant.

2. E. CICHORACEARUM DC. [Figs. 140, 151]

Mucor Erysiphe Leyss. Fl. Hal. 305. 1783.

Erysiphe cichoracearum DC. Fl. Fr. **2**: 274. 1805; Wint.;

Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 33. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 94. 1885; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 404. *f. 4* (excl. syn. *E. sepulta*). 1887; Atkins. Journ. Elisha Mitch. Sci. Soc. **7**: 65. 1891; Burr.; Ell. & Everh. N. Amer. Pyren. 12 (excl. syn. *E. sepulta*). 1892.

E. varium Fr. Obs. Myc. **1**: 206 (partim). 1815; **2**: 366 (partim). 1818.

Alphitomorpha communis, var. *cichoracearum* Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 31. 1819.

A. depressa Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 34. 1819; Wallr. Fl. Crypt. Germ. **2**: 758. 1833.

A. circumfusa Schlecht. Berl. Ges. Nat. Freund. Verh. **1**: 49. 1819.

A. bardanae Wallr. Ann. Wett. Ges. **4**: 239. 1819.

A. cynoglossi Wallr. Ann. Wett. Ges. **4**: 240. 1819.

A. artemisiae Wallr. Ann. Wett. Ges. **4**: 240. 1819.

Erysibe biocellata Ehrenb. N. Act. Acad. Leop. Car. Nat. Cur. **10**: 211. *pl. 13*. 1821; Lk.; Willd. Sp. Pl. **6**: 109. 1824.

E. depressa, var. *artemisiae* Wallr. Ficin. & Schub. Fl. Gegend. Dresd. **2**: xix. 1823.

E. communis Schlecht. Fl. Berol. **2**: 168. 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 232 (partim). 1844.

E. circumfusa Schlecht. Fl. Berol. **2**: 169. 1824; Lk.; Willd. Sp. Pl. **6**: 109. 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 232 (partim). 1844.

E. depressa Schlecht. Fl. Berol. **2**: 169. 1824; Lk.; Willd. Pl. **6**: 110. 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 232 (partim). 1844.

E. communis, var. *cichoracearum* Lk.; Willd. Sp. Pl. **6**: 107. 1824.

E. lamprocarpa, var. *plantaginis* Lk.; Willd. Sp. Pl. **6**: 109. 1824.

Erysiphe artemisiae Grev. Fl. Edin. 459. 1824.

E. arctii Grev. Fl. Edin. 460. 1824.

E. asperifoliorum Grev. Fl. Edin. 461 (partim). 1824.

E. bardanae Chev. Fl. Par. **1**: 381. 1826.

E. communis Fr. Syst. Myc. **3**: 239 (partim). 1829; Berk.; Sm. Eng. Fl. **5**: 325 (partim). 1836.

E. communis, var. *cichoracearum* Duby, Bot. Gall. **2** : 869. 1830.

A. lamprocarpa, var. *plantaginis* Duby, Bot. Gall. **2** : 869. 1830.

E. compositarum Duby, Bot. Gall. **2** : 870 (excl. var. *cynarae*). 1830.

E. knautiae Duby, Bot. Gall. **2** : 870. 1830.

Alphitomorpha horridula Wallr. Fl. Crypt. Germ. **2** : 755 (partim). 1833.

A. lamprocarpa, var. *plantaginis* Wallr. Fl. Crypt. Germ. **2** : 758. 1833.

A. communis Wallr. Fl. Crypt. Germ. **2** : 758 (partim). 1833.

Erysiphe ambrosiae Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1** : 22. 1882.

E. verbenae Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1** : 22. 1882.

E. phlogis Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1** : 21. 1882.

E. asterum Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1** : 23. 1882.

Erysibe lamprocarpa Rabenh. Deutschl. Krypt. Fl. **1** : 232 (partim). 1844.

E. horridula Rabenh. Deutschl. Krypt. Fl. **1** : 235 (partim). 1844.

Erysiphe scorzonerae Cast. Cat. Pl. Mars. 189. 1845.

E. lamprocarpa Kickx. Fl. Crypt. Env. Louv. 140 (partim). 1835; Dur. & Mont. Fl. d'Algér (Crypt.) 567. 1846–9; Lév. Ann. sci. nat. III. **15** : 163. *pl. 10. f. 31* (partim). 1851; Cooke, Micr. Fung. 220. *pl. 12. f. 250, 251.* 1865; de Bary, Beitr. Morph. Phys. Pilz. **1** : § xiii. 49. 1870; Cooke, Handb. Brit. Fung. **2** : 650. *f. 317.* 1871; Karst. Myc. Fenn. 192 (partim). 1873; Sacc. Syll. Fung. **1** : 16. 1882; Jacz. Bull. l'Herb. Boiss. **4** : 730. 1896; Oudem. Rév. Champ. Pays.-Bas. **2** : 94. 1897.

E. orontii Cast. Supp. Cat. Pl. Mars. 52. 1851.

E. linkii Lév. Ann. sci. nat. III. **15** : 161. *pl. 10. f. 20.* 1851; Cooke, Micr. Fung. 220. *pl. 12. f. 248, 249.* 1865; Cooke, Handb. Brit. Fung. **2** : 650. 1871; Karst. Myc. Fenn. **2** : 191.

1873; Sacc. Syll. Fung. **1**: 16. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. **1**: 30. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 92. 1885; Jacz. Bull. l'Herb. Boiss. **4**: 727. 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 93. 1897.

E. Montagnei Lév. Ann. sci. nat. III. **15**: 169. *pl. 11. f. 36* (excl. syn. *E. lappae* Cast). 1851; Cooke, Micr. Fung. 220 (excl. syn. *E. compositarum*, var. *cynarae*). 1865; Cooke, Handb. Brit. Fung. **2**: 651. 1871; Sacc. Syll. Fung. **1**: 17. 1882.

E. horridula Lév. Ann. sci. nat. III. **15**: 170. *pl. 11. f. 37.* 1851; Cooke, Journ. of Bot. **4**: 98. 1866; Cooke, Handb. Brit. Fung. **2**: 652. 1871; Karst. Myc. Fenn. **2**: 194. 1873; Sacc. Syll. Fung. **1**: 17. 1882; Oudem. Rév. Champ. Pays.-Bas. **2**: 96. 1897.

Uncinula adunca, var. *artemisiae* Prod. Fl. Bat. **2**: 33. 1866.

Erysiphe spadicea Berk. & Curt. Grevillea, **4**: 159. 1876; Sacc. Syll. Fung. **1**: 18. 1882.

E. horridula, var. *cynoglossi* Sorok. 147. *pl. 88* (*13*). *f. 191–194.* 1889.

E. lamprocarpa, var. *plantaginis* Sorok. Rev. Myc. 148. *pl. 89* (*15*). *f. 240.* 1889.

Erysibe cichoracearum DC. Schroet.; Cohn's Krypt. Fl. Schles. **3**: 238. 1893.

EXSICC.: Westend. Herb. Crypt. Belg. 226, 409, 410, 411, 553 (f only), 1058; Rab. Fung. Eur. 561, 673, 1059, 1067, 1149, 1325, 1523, 2320, 2520; Rab. Herb. Myc. ed. 2, 470, 471, *485, 486, *669; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 403, 518, 1108 (B only), 1109 (A only), 1304 (A only), 1516, 1517; *ed. 2, ser. 1, 111, 508 (B only), 814, 1016, 1017; de Thüm.; Fung. austr. 237, 452, 456, 754, 856, 1043, 1144, *1145, 1247, 1250; de Thuem. Myc. univ. 55, 449, 1353, 1840; *de Thuem. Fung. exot. dec. 32, 34; Oudem. Fung. Neerl. Exsicc. 75, 76, 160; Roumeg. Fung. Gall. exsicc. 2339, 3738; Roumeg. Fung. Sel. Gall. Exsicc. 261, 533; Fckl. Fung. Rhen. 648, 650, 652, 653, 655, 657, 658, 670, 673, 674, 688, 1567, 1739, 1740; *Seym. & Earle, Econ. Fung. 46, 293a and b, 295a and b, 305, 321, 346; *Ell. & Everh. Fung. Columb. 312, 313, 613; Syd. Myc. March. 652, 656, 840, 1145, 1146, *1147, 1148, 2326, 2327, 2766, 3051, 3460, *3918, *4015; *Gandog. Fl. Alger. Exsicc. 1981; Sacc.

Myc. Ven. 608, 904; Bri. & Cav. Fung. par. 263, 264; Rehm. Ascom. 396, 397; Cooke, Fung. Brit. Exsicc. 97, 199, *200, 466; ed. 2, 285, 287; Vize. Fung. Brit. 96, 199; Ayres. Myc. Brit. 77; *Erikss. Fung. Par. Scand. 37a, 146, 147a and b, 148b, 289, 339; *Fl. Exsicc. Austr.-Hungar. 1173; Ell. & Everh. N. Amer. Fung. 2916, 3006; Rav. Fung. Car. Exsicc. 69; *Kneiff. & Hartm. Pl. Crypt. Bad. 13, 161; Wahrlich, Parasit. Pilz. 25, 26, 27 (in Herb. Hort. Imp. Petropol.); Lib. Pl. Cr. Ard. 183 (in Herb. Jarb. Bot. Bruxelles).

Sub *Erysiphe polygoni;* Rab. Fung. Eur. 1066, 1742, 1917; *Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 1108B, ed. 2, ser. 1. 509A; *Krieg. Fung. Saxon. 826; Syd. Myc. March. 1144; *Karst. Fung. Fenn. 785; Berk. Brit. Fung. 202; Klotsch. Herb. Myc. 60; Westend. Herb. Crypt. Belg. 1058; Roumeg. Fung. Gall. Exsicc. 2271; de Thüm. Fung. austr. 1250; Fckl. Fung. Rhen. 670.

Sub *E. taurica;* Roumeg. Fung. Sel. Exsicc. 4564.

Sub *Sphaerotheca Castagnei;* Rab. Fung. Eur. 1048, 1051, 1916; de Thuem. Fung. austr. 441; Cooke, Fung. Brit. Exsicc. ed. 2, 591, 592; Sacc. Myc. Ven. 630.

Sub *Erysiphe galeopsidis;* Westend. Herb. Crypt. Belg. 409; Desmaz. Pl. Cr. Fr. ser. 1, 1517.

Amphigenous; mycelium usually evanescent, sometimes persistent and effused, usually white, rarely with a pinkish tinge; perithecia sub-globose or globose-depressed, often becoming concave, gregarious or scattered, 80–140 μ in diameter, very rarely 140–180 μ, cells variable in size, often very distinct, and 10–20 μ wide, sometimes smaller, 10 μ wide, and obscure; appendages very variable, long or short, brown or sometimes colorless, usually numerous, densely interwoven, vaguely branched, septate, light or dark-brown throughout, and from 2–4 times the diameter of the perithecium, but sometimes very few, and short or even rudimentary; asci usually numerous, about 10–15, but varying from 4–25, very rarely as many as 36, variable in size and shape, from narrowly ovate or subcylindrical to broadly ovate, or rarely subglobose, more or less stalked, 58–90 × 30–50 μ; spores 2, rarely (and never uniformly) 3, 20–28 × 12–20 μ, usually about 24 × 14 μ.

Hosts.—Achillea Millefolium, A. Ptarmica, Actinomeris squarrosa, Adenostyles alpina (3), *A. viridis, Ambrosia artemisifolia, A.*

psilostachya, *A. trifida* and var. *integrifolia*, *Amsinckia spectabilis*, *Anchusa Italica* (56), *A. officinalis* (22) (107) (229) (319) (345), *Antirrhinum Orontium*, *Aplopappus* sp., *Apocynum* (84), *Arctium majus*, *A. minus*, *A. nemorosum*, *Artemisia Absinthium*, *A. biennis* (60), *A. campestris*, *A. discolor* (6), *A. dracunculoides*, *A. glauca*, *A. Japonica*, *A. Ludoviciana*, var. *guapolodes*, *A. vulgaris*, *Asclepias variegata*, *Asperugo procumbens*, *Asperula odorata* (176), *Aster adscendens* (6), *A. canescens*, *A. communis*, *A. commutatus*, *A. conspicuus* (6), *A. cordifolius*, *A. corymbosus* (363), *A. diffusus* (10) (12) (265), *A. Drummondii* (265), *A. ericoides* and var. *villosus* (324), *A. foliaceus*, var. *Eatoni*, *A. Fremonti*, *A. grandiflorus* (239), *A. junceus* (265), *A. laevis* and var. *laevigatum*, *A. longifolius*, *A. macrophyllus* (61), *A. multiflorus* (6), *A. oblongifolius* (61), *A. paniculatus*, *A. prenanthoides*, *A. puniceus*, *A. sagittifolius*, *A. salicifolius* (60), *A. Shortii* (324), *A. Tradescanti*, *A. umbellatus* (60), *A. vimineus*, var. *foliolosus* (61), *Ballota nigra* (263), *Balsamorhiza sagittata*, *Boltonia asteroides*, *Bigelovia viscidiflora*, *Borago officinalis*, *Calendula officinalis* (205*), *Campanula* sp. (347), *C. glomerata* (235), *Cardamine* sp., *Carduus acanthoides*, *C. tenuiflorus* (56), *C. viridis* (230), *Carlina acaulis* (20) (272) (319), *Centaurea Jacea* (3) (290) (319) (345), *C. nigra*, *C. nigrescens*, *C. scabiosa*, *Cerinthe minor* (22), *Chrysopsis villosa*, *Cichorium Intybus*, *Clematis orientalis* (206), *C. altissimus* and var. *discolor*, *C. arvensis* (319), *C. cardunculus* (214), *C. eriophorus*, *C. heterophyllus*, *C. lanceolatus*, *C. oleraceus*, *C. rivularis* (319), *C. undulatus*, var. *canescens*, *Cousina uncinata* (239), *Crepis paludosa* (353), *C. parviflora*, *Crupina vulgaris*, *Cucurbita Pepo*, *Cynoglossum Morisoni*, *C. officinale*, *Dahlia* (324), *Dysodia chrysanthemoides* (363), *D. papposa* (386), *Echinospermum Lappula* (347), *E. Redowskii* (199), *E. Virginicum*, *Echium* (344), *E. Italicum* (389) *E. vulgare* (22) (263) (271) (272) (345) (377) (390) (391), *Ellisia Nyctelea*, *Epilobium tetragonum* (345), *Erigeron armerifolius* (6), *E. corymbosus* (6), *E. divaricatus* (6), *E. elatus*, *E. glabellus* (6), *E. macranthus*, *E. strigosus* (6), *Eriogonum nudum*, *Eupatorium cannabinum*, *E. perfoliatum*, *E. purpureum*, *Gaillardia aristata* (6), *Galium Aparine*, *G. boreale*, *G. triflorum*, *Geum urbanum* (353), *Gnaphalium sylvaticum*, *Grindelia squarrosa*, *Gutierrezia Euthamiae*, *Helenium autumnale*, *Helianthella Parryi* (363), *Helianthus annuus*, *H. Californicus*, var. *Utahensis* (6), *H.*

doronicoides, *H. giganteus*, *H. grosse-serratus* (265), *H. Maximiliani*, *H. orgyalis*, *H. petiolaris*, *H. rigidus*, *H. strumosus*, *H. tuberosus*, and var. *subcanescens*, *Helichrysum arenarium*, *Hieracium albiflorum*, *H. boreale* (205*), *H. Canadense* (61), *H. incisum* (230), *H. lycopsifolium*, *H. murorum* (3) (345), *H. prenanthoides*, *H. sabaudum* (214) (263), *H. vulgatum* (319), *Humulus Lupulus* (60), *Hydrophyllum Canadense*, *H. capitatum*, *H. macrophyllum* (324), *H. occidentale* (259), *H. Virginicum*, *Hyoscyamus albus*, *H. niger*, *Hypericum humifusum* (18), *Inula Britannica* (319), *I. Helenium* (272) (363), *I. hirta*, *I. Oculus-Christi*, *I. salicina*, *Iva frutescens* (60), *I. xanthifolia* (363), *Kuhnia eupatorioides*, *Lactuca muralis* (345), *L. pulchella* (6), *L. Scariola*, *L. viminea* (344), *Laportea bulbifera*, *Lapsana communis* (20), *Lithospermum arvense*, *L. officinale* (22) (390), *Lycodesmia juncea*, *Lycopsis arvensis* (107) (214), *Lycopus Europaeus*, *Madia glomerata*, *Mentha aquatica*, *M. arvensis*, *Mertensia maritima*, *M. Sibirica*, *Mikania scandens* (10) (12), *Mimulus luteus* (363), *Myosotis intermedia* (56) (263), *M. sparsiflora* (345), *M. sylvatica* (56), *Napaea dioica*, *Nicotiana Tabacum*, *Onopordon Acanthium* (319), *Onosma simplicissimum* (347), *Parietaria debilis* (6), *P. officinalis* (230), *P. Pennsylvanica*, *Phacelia circinata*, *P. Menziesii*, *Phlomis tuberosa*, *Phlox divaricata*, *P. Drummondii* (366), *P. paniculata*, *Pilea pumila* (265), *Plantago Bellardi*, *P. Coronopus*, *P. Kamtschatica*, *P. Lagopus*, *P. lanceolata*, *P. major* and var. *Asiatica*, *P. maritima*, *P. media*, *P. Psyllium* (214), *Potentilla* sp. (347), *P. bifurca* (350), *P. viscosa* (235), *Prenanthes alba* (60), *P. purpurea*, *Prunella vulgaris* (107), *Pulmonaria mollis*, *P. officinalis*, *Rudbeckia hirta*, *R. occidentalis* (363), *Rumex Acetosella* (319), *Salvia glutinosa* (15) (73*) (271) (272), *Saussurea salicifolia*, *Scorzonera hirsuta* (66), *S. Hispanica*, *S. humilis*, *Scutellaria lateriflora*, *Senecio hydrophilus*, *S. sylvaticus*, *S. vulgaris*, *Sesbania* (159), *Silphium terebinthinaceum*, *Solanum Carolinense*, *Solidago Canadensis*, *S. Missouriensis* (6) (386), *S. nana*, *S. occidentalis* (6), *S. rigida* (6), *S. serotina*, *Sonchus arvensis*, *S. asper*, *S. oleraceus*, *Stachys palustris* (199) (363), *Stevia* sp., *Symphytum officinale*, *S. tuberosum*, *Tanacetum vulgare*, *Taraxacum officinale* (3) (132) (163) (176) (177) (271) (272) (290), *Tecoma radicans* (265), *Teucrium Canadense* (366), *T. Chamaedrys* (237), *Tragopogon porrifolius*, *T. pratensis*, *Trigonella* (206), *Valeriana officinalis*,

Verbascum nigrum, *V. phlomoides* (20) (230) (272), *V. pulverulentum* (319), *V. thapsiforme* (263), *V. Thapsus* (230), *Verbena angustifolia*, *V. Aubletia*, *V. bracteata* (61), *V. hastata*, *V. laevis*, *V. officinalis* (60), *V. stricta*, *V. urticifolia*, *Verbesina encelioides* (363), *V. occidentalis* (9), *Vernonia Baldwini*, *V. fasciculata*, *V. Noveboracensis*, *Xanthium Canadense*, *X. Strumarium*.

Distribution.—EUROPE: Britain, France, Belgium, Netherlands, Switzerland, Italy, Germany, Austria-Hungary, Servia (318), Greece, Denmark, Norway, Sweden, Lapland (192), Finland (192), Russia.

AFRICA: Algeria, Egypt.

ASIA: Persia (389), Turkestan, Siberia (Minussinsk), Japan.

NEW ZEALAND.

NORTH AMERICA: United States—Maine, New Hampshire, Vermont, Massachusetts, New York, Pennsylvania, Maryland, New Jersey, Virginia, North and South Carolina, Ohio, Michigan, Indiana, Alabama, Illinois, Mississippi, Wisconsin, Missouri, Iowa, Minnesota, South Dakota, Kansas, Montana, Idaho, Wyoming, Colorado, Utah, California, Washington. Canada—Newfoundland, New Brunswick, Ontario.

E. cichoracearum, although very variable, is not as a rule a difficult species to recognize under the microscope. In rare cases, it closely approaches certain forms of *E. polygoni*, with which it has been much confused; *E. cichoracearum* and *E. polygoni*, however, must certainly be considered as distinct species. In by far the greatest number of cases, the present species may be at once distinguished by the numerous, regularly 2-spored asci. The comparatively few forms of *E. polygoni* which have numerous asci are always 4–8-spored. Although *E. cichoracearum* shows rarely one or two asci in a perithecium with 3 spores, and although in *E. polygoni*, as a rare exception, an ascus may contain only 2 spores, yet as the result of an examination of many hundred specimens of both species, it appears to me safe to consider the 2-spored ascus as the central specific character of *E. cichoracearum*, and the 3–8-spored ascus as that of *E. polygoni*. Usually unfailing characters are also found in the large wider asci and larger, distinctly wider spores of the present species. Often, moreover, *E. cichoracearum* has a habit, difficult to define, by which it is known from *E. poly-*

goni, as, *e. g.*, on the leaves of *Plantago*, where the gregarious perithecia more or less completely surrounded by the densely interwoven, deep brown appendages give a characteristic appearance. On the other hand, however, especially in cases where the perithecia are small and scattered, forms of *E. cichoracearum* occur which cannot be separated by the lens alone, or even by microscopic examination of any external characters, but in these cases a safe distinction will be found in the regularly 2-spored asci with larger and wider spores. As a rule, too, *E. cichoracearum* is not found with the few distinct appendages characteristic of many forms of *E. polygoni*; on *Hydrophyllum Virginicum*, however, a form occurs with small perithecia (sometimes only 88 μ in diameter), few asci (often only 6), and appendages few and more distinct than usual; the asci, however, are regularly 2-spored.

It must be noted here that *E. cichoracearum* has been frequently stated to possess asci with 3–4 spores. Léveillé described and figured *E. horridula* (the name given to the form of *E. cichoracearum* on *Symphytum* and *Lycopsis*) with 3–4 spores. In Léveillé's own specimens, however, in Berkeley's herbarium at Kew, from the same locality (Magny en Vexin) as that mentioned in Ann. Sci. Nat., the asci are regularly 2-spored. In other specimens on *Symphytum* I have occasionally found 3 spores, but only by way of exception. Léveillé also described *E. lamprocarpa* (the form of *E. cichoracearum* on *Plantago*, etc.) as 4–8-spored, but this was evidently only by a slip, as *E. lamprocarpa* is figured as 2-spored, and is placed in the key in the bisporous section of the genus. *E. spadicea* Berk. & Curt. has been correctly referred to *E. cichoracearum*; the type specimen at Kew shows regularly bisporous asci, although the species was described as having 8 spores.

E. cichoracearum has been confused not only with *E. polygoni*, but also with *E. taurica* and *Sphaerotheca Castagnei*. To *E. taurica* the present species is certainly closely allied, but may be distinguished by the smaller size of the perithecia, asci and spores; *Sphaerotheca* is widely separated by the single ascus.

It has often been stated that *E. cichoracearum* occurs on *Taraxacum officinale*, and in many exsiccati specimens supposed to be this species on this host have been published. All these, how-

ever, have proved on examination to be *Sphaerotheca humuli*, var. *fuliginea*, and there seems reason to doubt if *E. cichoracearum* has really ever occurred on *Taraxacum*.

In the case of the species which occurs commonly (in the conidial condition) on the leaves of *Cucumis* and *Cucurbita* in cultivation, the determination has apparently been equally unsatisfactory. Nearly all mycologists (*e. g.*, Léveillé, Fuckel, Jaczwski, Passerini, etc.), refer the fungus to *Sphaerotheca Castagnei;* Schroeter, however, places it under *E. polygoni*, and records the finding of specimens with perithecia on *Cucurbita Pepo*. The perithecial stage of this fungus on *Cucurbita* and *Cucumis* is evidently rare, and in all the herbarium specimens and those in exsiccati (all named *Sphaerotheca Castagnei*) examined I have found only the conidial stage. I have, however, collected specimens on *Cucurbita Pepo*, at Reigate, Surrey, England, in 1898, with a few perithecia, and the fungus here was undoubtedly *E. cichoracearum*, the asci being regularly 2-spored. It is interesting to note that a few American authors have similarly determined the fungus ; *e. g.*, Humphrey (169) records *E. cichoracearum* on cucumber (*Cucumis*). It is, of course, possible that more that one species of *Erysiphe* occurs on these host-plants, but in the present case it seems more probable that the fungus has been constantly named *Sphaerotheca Castagnei* merely because this species was originally recorded on these host-plants, and it would be very interesting to know if any example with perithecia of *Sphaerotheca* really exists.

The *Erysiphe* on *Valeriana officinalis* has been referred without exception (by Fuckel, Magnus, Karsten, Schroeter, etc.) to *E. polygoni*, but all the specimens I have seen so named, have proved on examination to be *E. cichoracearum*. On the other hand, the *Erysiphe* which occurs on thistles has been referred entirely to *E. cichoracearum*, while, as a matter of fact, on the stems of *Cnicus lanceolatus*, etc., an interesting form of *E. polygoni* occurs not uncommonly. Similarly, the *Erysiphe* on *Anchusa* and *Echium* has been referred to *E. cichoracearum*, but all the specimens I have seen so named in exsiccati, etc., prove to be *E. polygoni*. The fungus on *Cnicus eriophorus* (in Montagne's herbarium) referred to *E. taurica* by Léveillé (214) is *E. cichoracearum*. The *Erysiphe* on species of *Galium*, which has hitherto been referred to

E. polygoni also belongs to the present species, and together with the forms on *Mentha*, *Lycopus* and *Scutellaria* are peculiar in usually showing on the living host-plant no trace of spores in the asci. These forms, as well as their connection with *E. galeopsidis*, are discussed further.

A rather marked form of *E. cichoracearum* occurs on *Senecio vulgaris* (Margery, Reigate, England, Oct., 1898). Here the mycelium is persistent and covers the stems with a continuous white covering, in which the perithecia are more or less immersed, giving an appearance very similar to that of the forms of *E. polygoni* on *Liriodendron*, *Diervilla*, etc. We not unfrequently find, however, *E. cichoracearum* on other host-plants with a thin effused persistent mycelium on the leaves, as in some American examples on species of *Helianthus* and on *Ambrosia trifida*—sometimes, as in some specimens on *Hydrophyllum Virginicum* the mycelium has a decidedly pink color.

An American form on *Bigelovia viscidiflora* (*B. Douglasii*) (Willis, Montana, Oct., 1888, leg. F. W. Anderson, in Herb. Missouri Bot. Gard.) is remarkable for the often large size of the perithecia, which measure from 100–175 μ, and for the numerous asci, which are sometimes as many as 36. In these characters the fungus approaches both *E. polygoni* var. *sepulta* and *E. taurica*; from the former it differs in the regularly bisporous asci, from the latter in the slightly smaller perithecia, apparently not becoming conspicuously concave or pezizoid, slightly smaller asci and smaller spores. Although this form has been generally referred to *E. cichoracearum* by American botanists, it must be considered a marked form of this species in the larger perithecia and more numerous asci (I have not seen elsewhere in *E. cichoracearum* perithecia larger than 140 μ in diameter), and certainly makes the nearest approach of any American *Erysiphe* to the Old World species *E. taurica*. I have seen only the one specimen quoted above, and this, unfortunately, for the most part scarcely mature.

In Grevillea, **15**: 98. 1887 the following description of an *Erysiphe* was given: " *E. vitigera* Cke. et Mass. Hypophylla, mycelio floccoso, persistente, peritheciis gregariis, minutissimis (4 mm. diame.), sphaeroideis; appendicibus obsoletis vel cum mycelio intertextis, ascis poriformibus (4 in singulo perithecio)

50 × 30 μ, bisporis. Sporidiis ellipticis, hyalinis, 18 × 9 μ. On leaves of grape vine. Near Melbourne (Mueller). Allied to *E. lamprocarpa*, but apparently distinct from all the disporous species. We have seen the floccose mycelium before, but without perithecia. Hitherto we have not been successful in detecting or identifying the conidia. Destructive to the vines in Australia, but there is no evidence on which to connect it with *Oidium Tuckeri*, but on the contrary, the floccose mycelium is much more woolly, and commonly sterile, at least in so far as we have seen specimens. Leaves and twigs sent to us from Australia last year with a thick cottony-white mycelium, but without fruit of any kind, was probably the same species. It has every appearance of being a dangerous pest." On the sheet with the type-specimens at Kew, there is a drawing (reproduced in Cooke's Handbook of Australian Fungi) (89) or of an ascus with two spores, but on the type-specimens themselves I can find no fungus. The host-plant is one of the forms of *Vitis vinifera* in which the under surface of the leaves, the young wood, etc., are covered with a more or less dense cobwebby tomentum, and it appears that this has been mistaken for floccose mycelium, as of this there is no trace. The description given above of the mycelium—" commonly sterile," etc.—favors this view. It is possible that the perithecia which were seen were stray ones of *E. cichoracearum*.

The fungus described by de Thuemen (354) as *Oidium tabaci*, on *Nicotiana Tabacum*, from Portugal is apparently the conidial form of *E. cichoracearum*, as on specimens sent to me by Professor Gennardius, from Argos, Greece (named *O. tabaci*), there occur numerous perithecia of this *Erysiphe* (see Passinini 272).

3. E. GALEOPSIDIS DC. [Figs. 127–129]

Mucor Erysiphe L. Sp. Pl. **2**: 1186 (partim). 1753.

Erysiphe galeopsidis DC. Fl. Fr. **6**: 108. 1815; de Bary, Beitr. Morph. Phys. Pilz. **1**^{3}: §xiii. 49. 1870; Sacc. Syll. Fung. **1**: 16. 1882; Wint.; Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 33. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 93. 1885; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 404. 1887; Burr.; Ell. & Everh. N. Amer. Pyren. 13. 1892; Jacz. Bull. l'Herb. Boiss. **4**: 731. 1896; Oudem. Rév. Champ. Pays.-Bas. **2**: 95. 1897.

Alphitomorpha communis, var. *labiatarum* Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 31. 1819.

A. lamprocarpa Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 33. 1819.

A. ballotae Wallr. Ann. Wett. Ges. **4**: 239. 1819.

A. labiatarum Wallr. Ann. Wett. Ges. **4**: 241. 1819.

Erysibe lamprocarpa, var. *galeopsidis* Ficin. & Schub. Fl. Gegend. Dresd. **2**: 305. 1823.

E. lamprocarpa Schlecht. Fl. Berol. **2**: 169. 1824; Lk.; Willd. Sp. Pl. **6**: 108 (excl. var. *plantaginis*). 1824.

E. communis, var. *labiatarum* Lk.; Willd. Sp. Pl. **6**: 106. 1824.

Erysiphe labiatarinm Chev. Fl. Par. **1**: 380. 1826.

E. communis Fr. Syst. Myc. **3**: 239 (partim). 1829.

E. lamprocarpa; var. *galeopsidis* Duby, Bot. Gall. **2**: 869. 1830.

Alphitomorpha lamprocarpa ; var. *labiatarum* Wallr. Fl. Crypt. Germ. **2**: 757. 1833.

Erysiphe quisquiliarum Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1**: 23. 1882.

E. chelones Schwein. Syn. Fung. Am. Bor. 270. 1834; Sacc. Syll. Fung. **1**: 21. 1882.

E. lamprocarpa Kickx. Fl. Crypt. Env. Louv. 140. 1835; Lév. Ann. sci. nat. III. **15**: 163 (partim). 1851; Karst. Myc. Fenn. **2**: 192 (partim). 1873.

Erysibe lamprocarpa Rabenh. Fl. Lusat. **2**: 420. 1840.

E. lamprocarpa, var. *labiatarum* Rabenh. Deutschl. Krypt. Fl. **1**: 232. 1844.

E. galeopsidis DC.; Schroet.; Cohn's Krypt. Fl. Schles. **3**: 237. 1893.

EXSICC.: Fckl. Fung. Rhen. 654, 656; Karst. Fung. Fenn. Exsicc. 172; Sacc. Myc. Ven. 612, *613, 902; Lib. Pl. Crypt. Ard. fasc. 2, 183; Cooke, Fung. Brit. Exsicc. ed. 2, 200 (spec. on *Stachys* only), 596; Desmaz. Pl. Cr. Fr. ed. 1, ser. 1, 516; ser. 2, *110; de Thüm. Myc. Univ. 1252; Syd. Myc. March. 336; Westend. Herb. Crypt. Belg. 409; Rab. Fung. Eur. 1738, 1740, 1741; de Thüm. Fung. austr. 753, *1043, 1142; Roumeg Fung. Gall. Exsicc. 2451; Rab. Herb. Myc. ed. 2, 485; Sacc. Myc. Ven. 613; & 1491 sub *Sphaerotheca Castagnei*; *Kneiff. & Hartm. Pl. Crypt. Bad. 160; *Erikss. Fung. Par. Scand. 37b.

Hosts.—*Ballota nigra, Chelone glabra, Chelonopsis moschata, Eupatorium ageratoides* [?], *Galeopsis Tetrahit, G. versicolor, Lamium album, L. amplexicaule* (176) (230), *L. Galeobdolon, L. maculatum, L. intermedium, L. purpureum, Leonurus Cardiaca, Marrubium vulgare, Phlomis Herba-venti* (172), *Salvia* sp. (176), *S. verticillata* (3) (290), *Scutellaria lateriflora* (61), *S. parvula* (61), (363), *Stachys alpina, S. aspera* and vars. *glabra* (324) and *Japonica, S. ciliata* and var. *pubens, S. cordata* (324), *S. Germanica, S. melissaefolia, S. palustris, S. sylvatica, Teucrium Canadense, Verbena urticifolia* (10).

Distribution.—Europe: Britain, France, Spanish Peninsula (110), Belgium, Netherlands, Switzerland (176), Italy, Austria-Hungary, Denmark, Norway, Sweden, Russia.

Asia: Turkestan (Seravschan) (206), Siberia (Minussinsk) (311) (347), Japan.

North America: United States—Massachusetts, New York, Delaware, Michigan, Indiana, Illinois, Wisconsin, Minnesota, South Dakota, Kansas, Montana, Wyoming, Washington; Canada—Newfoundland, Ontario.

De Bary (99, p. 49), in 1870, revived the name *E. galeopsidis* DC. for the *Erysiphe* on *Galeopsis Tetrahit, Stachys sylvatica* and *Lamium purpureum*, distinguishing it from *E. lamprocarpa* (*E. cichoracearum*) described as having "haustoria exappendiculata v. appendiculata, non lobulata," by the presence of "haustoria lobulata." De Bary made the following observations on *E. galeopsidis*: "Diese Form unterscheidet sich von der vorigen (*E. lamprocarpa*) durch die gelappten Haustorien-Anhängsel, sie ist sonst der auf *Plantago* und Borragineen wachsenden *lamprocarpa* sehr ähnlich. Eine Haupteigenthümlichkeit, wegen deren ich sie, zur Zeit weingstens, von allen anderen Formen trennen muss, ist die, dass sie nicht wie letztere noch auf dem lebenden Pflanzentheil Sporen in ihren Ascis bildet, sondern hier immer ohne Sporen vorkommt."

All subsequent authors have followed De Bary in maintaining *E. galeopsidis* as a distinct species, and have relied on the lobed haustoria and absence of spores in the ascus as separative characters from *E. cichoracearum*. Most authors state that the spores (two in number) are produced in the following year, and that the

species is confined to certain host plants belonging to the Labiatae. In the size, etc., of the perithecia, nature of appendages, number and size of asci, etc., there is no difference—as indeed is generally admitted—between *E. galeopsidis* and *E. cichoracearum*, so that the claim of the former to rank as a distinct species rests on two supposed separative characters, viz.: the lobed haustoria and the non-development of spores on the living host-plant.

This latter peculiarity is found also as a rule in *E. graminis*, but we must notice that in this species spores are sometimes produced in late summer or autumn, so that in *E. graminis*, at least, it is seen that this character is not one of specific importance.

So long, however, as the absence of spores and the presence of lobed haustoria could be considered as correlated characters, and ones not occurring in *E. cichoracearum*, *E. galeopsidis* could be maintained as a distinct species. Some cases I have examined, however, make me doubt if we can consider either of these characters as absolutely characteristic of *E. galeopsidis*. In the examination of a large amount of material I have certainly found that the *Erysiphe* on species of *Lamium*, *Galeopsis*, *Stachys*, etc., invariably contain asci without any trace of spores, and in all cases where examination was made the mycelium was found to possess lobed haustoria. But, on the other hand, as regards this character of the non-production of spores, there are forms of *E. cichoracearum* which appear to be connecting links. Such are the forms on *Mentha arvensis*, *M. aquatica*, *Lycopus Europaeus* and *Scutellaria lateriflora*. On these host-plants, some specimens of the fungus, apparently mature, have perithecia in which the asci show no trace of spores, and are in fact indistinguishable, as regards perithecia, from *E. galeopsidis*; in other specimens two more or less well-formed spores are found in the ascus. The haustoria of the fungus on these hosts are not lobed (although there is sometimes a tendency for them to have a crenulate margin), and for this reason, probably, De Bary placed the fungus on *Mentha* and *Lycopus* under *E. cichoracearum*. The fungus on *Scutellaria* very rarely shows any signs of the formation of spores in the ascus, and it is probably on this account that Burrill places it under *E. galeopsidis*; the haustoria, however, are not definitely lobed. Another striking case is that afforded by the fungus on species of

Galium. Curiously enough, this form in Europe has been referred by all botanists to *E. communis* (*E. polygoni*), although it undoubtedly belongs to *E. circhoracearum*, of which it appears to be a form approaching *E. galeopsidis.* In all the European specimens I have examined the perithecia have contained asci without any trace of spores, and the habit, size, shape and number of asci, etc., further show that the fungus does not belong to *E. polygoni.* Moreover, in Turkestan specimens on *Galium boreale* and other species of the genus, and in American ones on *Galium aparine* and *G. triflorum* the asci are regularly bisporous with apparently ripe spores. For this reason American mycologists have placed the form under *E. cichoracearum.* The shape of the haustoria in the form on *Galium* appears also variable. These, although small, and in this respect very unlike those of *E. galeopsidis*, are sometimes, although rarely, distinctly lobed ; in other specimens they resemble those of *E. cichoracearum.* It appears, therefore, from the above cases, that *E. cichoracearum* is sometimes similar to *E. galeopsidis* in not producing spores on the living host-plant.

The difference in the size and shape of the haustoria in *E. cichoracearum* and *E. galeopsidis* is, as a rule, striking. The haustoria of the former species (examples on about thirty different host-plants were examined) are small and simple, those of the latter are much larger, much lobed irregularly, or often more or less reniform (deeply bi-lobed) in shape. Among some American examples, however, I was surprised to find in two specimens named *E. cichoracearum* on *Eupatorium ageratoides* (one from Madison, Wisconsin, Sept., 1882, L. H. Pammel) in Professor Earle's herbarium ; the other from Oregon, Illinois, Sept. 12, 1888 (in the Herbarium of the University of Illinois), haustoria of exactly the same size and shape as those on examples of *E. galeopsidis* on *Galeopsis.* Unfortunately, both these specimens are apparently rather young, and the asci contain no spores. It is, therefore, impossible to say whether we have in this case a form of *E. cichoracearum* with lobed haustoria, or whether it may not possibly be that of *E. galeopsidis*, hitherto supposed to be confined to Labiatae and *Chelone* among Scrophularineae, sometimes occurs on Compositae. In another case the fungus is undoubtedly *E. cichoracearum.* This is the specimen on *Sonchus arvensis* in Syd. Myc. March. 3051, and in

this example among simple haustoria some occur which are distinctly lobed (Fig. 131). These latter are not quite so large and certainly not so much lobed as in typical *E. galeopsidis*, but their occurrence tends to break down the distinction between the two forms.

Whilst, therefore, admitting that the form known as *E. galeopsidis* on *Galeopsis*, *Lamium*, *Stachys*, etc., is well characterized by the large, lobed haustoria and absence of spores on the living host plant, it seems that forms of *E. cichoracearum* exist in which the latter (and to some extent the former) character is found. Whether these intermediates are numerous enough to compel us to unite *E. galeopsidis* with *E. cichoracearum*, or whether the former should rank as a species, or more probably as only a variety, can only be proved by further observations, especially with regard to the haustoria of specimens of *E. cichoracearum* on its numerous host-plants. For this purpose young examples are in many cases necessary, as the mycelium is commonly evanescent in the mature condition of the fungus.

4. E. GRAMINIS DC. [Figs. 156, 159, 160]

Erysiphe graminis DC. Fl. Fr. **6**: 106. 1815; Lév. Ann. sci. nat. III. **15**: 165. *pl. 10. f. 33.* 1851; Tul. Sel. Fung. Carp. **1**: 212. 1861; Cooke, Micr. Fung. 220. *pl. 11. f. 235, 236.* 1865; Cooke, Handb. Brit. Fung. **2**: 651. 1871; Karst. Myc. Fenn. **2**: 193. 1873; Sacc. Syll. Fung. **1**: 19. 1882; Wint. in Rabenh. Krypt. Fl. Deutschl. **1**^{2}: 30. 1884; Karst. Act. Soc. Faun. Fl. Fenn. **2**: 93. 1885; Burr. in Ell. & Everh. N. Amer. Pyren. 15. 1892; Jacz. Bull. l'Herb. Boiss. **4**: 728. 1896; Oudem. Rév. Champ. Pays-Bas. **2**: 98. 1897.

Alphitomorpha communis, var. *graminearum* Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 31. 1819; Wallr. Fl. Crypt. Germ. **2**: 758. 1833.

Erysibe communis, var. *graminum* Lk. in Willd. Sp. Pl. **6**: 106. 1824.

Erysiphe communis Fr. Syst. Myc. **3**: 239 (partim). 1829.

E. communis, var. *graminum* Duby, Bot. Gall. **2**: 869. 1830; Rabenh. Deutschl. Krypt. Fl. **1**: 232. 1844.

E. communis, var. *graminis* Dur. & Mont. Fl. d'Algér. (Crypt.) 565. 1846–9.

Erysibe communis Rabenh. Fl. Lusat. 2: 419. (partim). 1840.

E. graminis DC. Schroet.; Cohn, Krypt. Fl. Schles. 3: 240. 1893.

EXSICC.: Bri. & Cav. Fung. Par. 174; Lib. Pl. Crypt. Ard. fasc. 2, 182; Roumeg. Fung. Gall. Exsicc. 766, 1163; Syd. Myc. March. 1139, 1350, *3461, *4123; Desmaz. Pl. Cr. Fr. ed. 1 ser. 1, 1109 (B only), *ed. 2, ser. 1, 509 B; Rab. Fung. Eur. 671; Karst. Fung. Fenn. Exsicc. 677; Rab. Herb. Myc. ed. 2, 473, 759; de Thüm. Fung. Austr. 1244; de Thüm. Myc. univ. 257; Fckl. Fung. Rhen. 659; Westend. Herb. Crypt. Belg. 554; Vize, Fung. Brit. 143; Klotzsch, Herb. Myc. 62; Jack, Lein. & Stizenb. Krypt. Bad. 829; Ayres, Brit. Fung. 23; Ell. & Everh. N. Amer. Fungi, 2813; Erb. Critt. Ital. ser. 1, 286 (in Herb. Mus. Florence); *Ell. & Everh. Fung. Columb. 505; *Erikss. Fung. par. scand. exsicc. 238; *Seym. & Earle, Econ. Fung. 96.

Usually epiphyllous, but sometimes amphigenous; mycelium more or less persistent, effused or forming scattered patches, at first white, frequently becoming pale brown or gray; perithecia large, 135–280 μ in diameter, usually about 200 μ, scattered or gregarious, globose-depressed, becoming concave, usually more or less immersed in the lanuginose persistent mycelium, which is formed of sparingly branched, curved, rather rigid thick-walled or solid, shining, interlaced hyphae, 4–5 μ wide, cells of perithecium obscure; appendages rudimentary, few or numerous, very short, simple or sparingly branched, pale brown; asci numerous, 9–30, usually from 15–20, varying from cylindrical to ovate-oblong, more or less longly pedicellate, $70–108 \times 25–40$ μ; spores 8 (or rarely 4), $20–23 \times 10–13$ μ, seldom produced on the living host-plant.

HOSTS.—*Agropyron caninum* (319), *A. glaucum*, *A. repens*, *A. scabrum*, *A. tenerum* (151), *Agrostis alba* (263), *A. exarata* (60), *Alopecurus agrestis* (56), *Apera Spica-Venti*, *Arrhenatherum avenaceum* (370), *Avena fatua* (66), *A. sativa*, *Beckmannia erucaeformis*, *Bromus asper* (319), *B. breviaristatus*, *B. madritensis* (16), *B. mollis* (3) (132) (224) (229) (319) (399), *B. rubens*, *B. secalinus* (319), *B. sterilis*, *B. tectorum* (399), *B. unioloides* (60) (151), *Dactylis glomerata*, *Deschampsia caespitosa* (319), *Elymus condensatus* (363), *Festuca arundinacea* (176), *F. elatior*, *F. gigantea* ( ), *F. heterophylla* (319), *Glyceria aquatica* (6), *G. nervata* (6), *Holcus*

mollis (319), *Hordeum jubatum* (6), *H. murinum* (272), *H. secalinum*, *H. vulgare*, *Lolium perenne* (107), *Milium effusum* (319), *Panicum sanguinale* (60), *Phleum pratense* (345), *Poa annua*, *P. Buckleyana*, *P. bulbosa*, *P. nemoralis*, *P. pratensis*, *P. serotina*, *P. sinaica* (233), *P. tenuifolia*, *P. trivialis*, *Saccharum officinarum* (143), *Secale cereale* (22) (69) (399), *Sesleria caerulea* (107), *Triticum sativum*, *T. Spelta*, *T. vulgare*.

Distribution.—EUROPE: Britain, France, Spanish Peninsula (101), Belgium, Switzerland (176), Italy, Germany, Austria-Hungary, Denmark, Norway, Sweden, Finland, Russia.

AFRICA: Algeria.

ASIA: Cyprus, Transcaucasia (338), Persia (233), Turkestan (Seravschan) (206), Siberia (235) (348), Japan.

AUSTRALIA: Thistle Island, Victoria and New South Wales (225).

NORTH AMERICA: United States—Massachusetts, New York, Pennsylvania, West Virginia (249), South Carolina (35), Michigan, Illinois, Mississippi (361), Iowa (165), South Dakota, Kansas, Montana, Idaho, Wyoming, Colorado, Nevada (363), California, Washington; Canada—Newfoundland, Ontario.

A very distinct species in the large size of the perithecium, and the large, usually numerous, asci. In these characters it somewhat recalls *E. taurica*, which differs, however, in the constantly bisporous asci. In *E. graminis* the asci usually show no trace of spores, being filled merely with granular protoplasm. When the spores are produced they are eight in number; according to Wolff, however, sometimes the number is only four. In Europe, *E. graminis*, as a general rule, is characterized by this absence of ascospores on the living host plant, and in the numerous material examined only two cases have occurred in which any signs of their production were observable. Among the twenty four examples of *E. graminis* in European exsiccati, mentioned above, only one (Rab. Fung. Eur. no. 671) showed spores in the ascus. This specimen was gathered on *Triticum sativum* in August; two of the asci, each containing 8 spores, are represented at Fig. 159. The other specimen (in the Herbarium of the Florence Museum) is on *Bromus sterilis*, and was collected in October. Here eight very young spores were seen in some of the asci. In the United

States, however, the development of ascospores in autumn, or even late summer, appears to be not uncommon. Anderson (6) mentions that ripe ascospores have been found on a species of *Poa* in Missouri in July, on *Beckmannia erucaeformis* and *Hordeum jubatum* in October, and on *Poa tenuifolia* in November, or usually by the middle of October. In a specimen on *Poa nemoralis*, gathered by Griffiths & Carter in South Dakota in August, I have found 8 well-formed spores in the ascus.

A very interesting account is given by Wolff (399) of the development and germination of the ascopores. This author found that if perithecia of *E. graminis* containing asci in which no spores are yet formed are placed in water (damp atmosphere, or even a position on water was found to produce no result) they showed, after two or three days, a change in the protoplasmic contents of the asci, leading up gradually, in the course of five or six days, to the formation of usually eight, or seldom only four, spores. These ascospores, like the conidia, were found to germinate readily in a damp atmosphere or in a drop of water. In dry air, however, at a temperature of 22°, they perished after 1 or 1½ hours. Under favorable conditions each ascospore was found to produce several germinating tubes, which at most reached to twice the diameter of the spore and which perished if after a period of 30 hours at the longest they failed to reach the epidermis of a suitable host-plant. If, however, this was reached the hyphae penetrated it and proceeded to form a mycelium in the same manner as those of a germinating conidium, *i. e.*, by first forming a haustorium, and then spreading from this center. It may be noted that Wolff tried to infect grasses with *E. communis* (*E. polygoni*), and conversely the host plants of *E. polygoni* (*Trifolium*, *Lupinus*, etc.) with *E. graminis*, but without success in either case.

The perithecia of *E. graminis*, when carefully isolated from the persistent mycelium are seen to possess only very short rudimentary appendages ; a few surrounding hyphae of the persistent mycelium often adhere to the perithecia when the latter are taken out, and these hyphae have apparently been mistaken by many authors for true appendages.

Garovaglio and Cattaneo (143) give an interesting account of the manner in which *E. graminis* attacks wheat. These authors

were unable to find any spores in the asci of perithecia occurring on living host-plants, but by placing leaves bearing perithecia in water, and leaving them in this position for some days under a bell jar, they were able to induce the formation of spores (8 in each ascus). *E. graminis* occasionally causes serious damage to forage and cereal crops, especially to wheat. It is stated in the Jour. Roy. Agric. Soc. England, for 1898 (184), that the fungus "appears to be greatly encouraged in wheat that is growing luxuriantly from an abundance of nitrogenous manure. . . . Sprinkling with flowers of sulphur may be useful if applied in the early stages of the attack." Outbreaks of the disease to a serious degree have been reported on the continent, occurring especially on winter-sown cereal crops; sulphur has been employed with success (see 188, 189, 191 and 400). Anderson (4), speaking of the attacks of *E. graminis* in Montana, U. S. A., says: "it affects chiefly the *Poas*, and is especially damaging to *P. tenuifolia*, one of our most valued forage grasses."

Oidium monilioides Desm. is the conidial stage of the present species.

The record of "*E. graminis*" on *Circaea Lutetiana* in Lamb. Fl. Myc. Belg. 2, 188, is evidently an error for *E. polygoni.*

Burrill (60, p. 15) concludes his description of *E. graminis* with the following remark: "Anderson says there are sometimes as many as 20 sporidia in an ascus—a variation not reported elsewhere." I cannot help thinking that "20 asci in a perithecium" was originally intended.

5. E. tortilis (Wallr.) Fr.

Alphitomorpha tortilis Wallr. Berl. Ges. Nat. Freund. Verh. **1**: 35. 1819; Wallr. Fl. Crypt. Germ. **2**: 756. 1833.

A. corni Wallr. Ann. Wett. Ges. **4**: 244. 1819.

Erysibe tortilis Lk. Willd. Sp. Pl. **6**: 111. 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 231. 1844; Schroet. in Cohn's Krypt. Fl. Schles. **3**: 241. 1893.

Erysiphe tortilis Fr. Syst. Myc. **3**: 243. 1829; Berk. Sm.-Eng. Fl. **5**: 327. 1836; Lév. Ann. sci. nat. III. **15**: 170. *pl. 11. f. 35.* 1851; Tul. Sel. Fung. Carp. **1**: 213. *pl. 5. f. 8.* 1861; Cooke, Micr. Fung. 221. *pl. 12. ff. 245, 246.* 1865; de

Bary, Beitr. Morph. Phys. Pilz. **1** : § XIII. 51. 1870. Cooke, Handb. Brit. Fung. **2** : 651. 1871; Sacc. Syll. Fung. **1** : 17. 1882; Wint. Rabenh. Krypt. Fl. Deutschl. $\mathbf{1}^2$: 32. 1884; Jacz. Bull. l'Herb. Boiss. **4** : 729. 1896; Oudem. Rév. Champ. Pays.-Bas. **2** : 95. 1897.

E. corni Duby, Bot. Gall. **2** : 870. 1830; Cast. Cat. Pl. Mars. 191. 1845.

EXSICC. : Rab. Fung. Eur. 672, 1521, 2033; Syd. Myc. March. 197, 1637; Desmaz. Pl. Cr. Fr. ser. 1, 266, * ed. 2, ser. 1, 815; Cooke, Fung. Brit. Exsicc. 98, ed. sec. 286; Vize, Fung. Brit. 97; Rehm, Ascom. 548; Berk. Brit. Fung. 204; Oudem. Fung. Neerl. Exsicc. 161; Roumeg. Fung. Gall. Exsicc. 974; Fckl. Fung. Rhen. 672; de Thüm. Fung. austr. 134; Sacc. Myc. Ven. 601; Rab. Herb. Myc. ed. 2, 472; de Thüm. Myc. univ. 258; Kunze, Fung. Select. exsicc. 61, 577; Westend. Herb. Crypt. Belg. 552; Vestergr. Microm. rar. select. 103; Erb. Critt. Ital. ser. 2, 986 (Herb. Mus. Florence); * Krieg. Fung. Saxon. 724; * Wartm. & Schenk, Schweiz. Krypt. 425.

Hypophyllous, very rarely epiphyllous; mycelium arachnoid, effused, evanescent, or very slightly subpersistent in scattered patches; perithecia densely gregarious to scattered, subglobose, 65–110 μ in diameter, cells distinct, 10–20 μ wide, usually over 15 μ, appendages well developed, very long, 10–20 times the diameter of the perithecium, 8–20 or more in number, 4–5 μ wide, brown, paler above, septate, flexuose, assurgent and fasciculate above, flaccid; asci 2–5, usually 4, broadly ovate to subglobose, with or without a stalk, 50–60 $\times$ 36–45 μ; spores 4–8, usually 8, 20–24 $\times$ 10–14 μ.

Hosts.—Cornus alba (3) (263), *C. sanguinea.*

Distribution.—EUROPE : Britain, France, Belgium, Netherlands, Switzerland, Italy, Germany, Austria-Hungary, Denmark, Sweden, Russia.

Distinct in the genus in the possession of the always long, well-developed appendages, assurgent and fasciculate above after the manner of some species of *Microsphaera.*

E. tortilis is frequently recorded (*e. g.*, by Bessey (40, p. 13), Trelease (366, p. 9), Rose (299)) from the United States on *Clematis Virginiana*, but the numerous specimens I have seen so named all belong to *E. polygoni*, and it seems very probable that

E. tortilis is confined to Europe. Burrill (60) records the present species as occurring in the United States, remarking as follows: "On *Cornus sanguinea*, Missouri (Tracy and Galloway). This is here included solely upon the authority given, and apparently upon one collection. In Europe the fungus is common on the same host, and as this is abundant in cultivation with us, it is altogether probable that this parasite may be frequently found."

It may be noticed that certain forms of *E. polygoni* (especially those on *Clematis*) are very similar to *E. tortilis* when examined under the microscope with the appendages flattened horizontally by the pressure of a cover-glass; when examined *in situ* on the leaf, however, it is seen that in *E. tortilis* the appendages are assurgent, altogether free from the surface of the leaf, and fasciculately wound together, while those of the form of *E. polygoni* in question spread horizontally on the leaf.

E. tortilis is sometimes recorded on *Cornus Mas*, but all the specimens so named that I have seen have proved to be *Phyllactinia corylea*. The record by Bagnis (18) of the occurrence of the present species on *Bellis annua* requires confirmation.

It is possible that the earliest specific name for this species is *corni*, given by Wallroth in the Ann. Wett. Ges., in 1819. The name *tortilis*, given by the same author in the Verhandl. Berl. Gesell. Nat. Freund., dates from the same year, and there appears to be no evidence as to which work appeared first. Under these circumstances, I have used the name *tortilis*, as being the one in general use, and as that retained by Wallroth himself in his later work, Flora Crypt. Germaniae.

6. E. TAURICA Lév. [Figs. 145–150, 152–154]

Erysiphe compositarum Duby, Bot. Gall. **2**: 870 (partim). 1830.

E. taurica Lév. Démidoff's Voy. Russ. mérid. (bot.) 119. *pl. 6. f. 5.* 1842; Dur. & Mont. Fl. d'Algér. (Crypt.) 566. 1846–9; Lév. Ann. sci. nat. III. **15**: 161. *pl. 10. f. 30.* 1851; Sacc. Syll. Fung. **1**: 16. 1882.

Erysibe depressa Rabenh. Deutschl. Krypt. Fl. **1**: 232 (partim). 1844.

Erisyphe picridis Cast. Cat. Pl. Mars. 192. 1845.

E. lappae Cast. Cat. Pl. Mars. 192. 1845.

E. Duriaei Lév. Ann. sci. nat. III. **15**: 165. *pl. 10. f. 32.* 1851; Sacc. Syll. Fung. **1**: 17. 1882.

E. lanuginosa Fckl. Bot. Zeit. 27. 1871; Sacc. Syll. Fung. **1**: 20. 1882.

E. Saxaouli Sorok. Rev. Myc. 146. *pl. 89* (15). *f. 231–236.* 1889; Sacc. Syll. Fung. **9**: 370. 1891.

E. armata Sorok. Rev. Myc. 146. *pl. 88* (13). *f. 195–203.* 1889; Sacc. Syll. Fung. **9**: 370. 1891.

E. alhagi Sorok. Rev. Myc. 147. *pl. 89* (15). *f. 237–239.* 1889; Sacc. Syll. Fung. **9**: 371. 1891.

E. pegani Sorok. Rev. Myc. 148. *pl. 91* (16). *f. 248–251.* 1889; Sacc. Syll. Fung. **9**: 371. 1891.

E. lichenoides Trab. & Sacc.; Sacc. Syll. Fung. **11**: 253. 1895.

E. papilionacearum Kom. Scripta Bot. Hort. Univ. Imp. Petropol. **4**: 271. 1895.

E. lanata P. Magn. Verh. k. k. zoöl.-bot. Gesell. Wien, **49**: 100. *pl. 3. f. 20–22.* 1899.

Microsphaera Bornmuelleriana P. Magn. Verh. k. k. zoöl.-bot. Gesell. Wien, **49**: 100. *pl. 3. f. 23–25.* 1899.

EXSICC.: Roumeg. Fung. Select. Exsicc. 6017; Rab. Fung. Eur. 1520; and 1735 sub *E. communis;* Sacc. Myc. Ven. 1169 sub *E. lamprocarpa;* Syd. Myc. March. 1076; and 1351 sub *E. cichoracearum;* de Thüm. Myc. Univ. 2153 sub *E. lamprocarpa;* Erb. Critt. Ital. ser. 2, 145 sub *E. communis;* and 445 sub *E. Montagnei* (in Herb. Mus. Florence).

Amphigenous, often covering the whole plant; mycelium usually persistent, effused, densely compacted, tomentose-membranaceous, or crustaceous, usually white, rarely pale buff in places, sometimes, however, wholly evanescent; perithecia scattered or gregarious, usually more or less immersed in the persistent mycelium, large, 135–240 μ in diameter, usually about 200 μ, soon becoming concave, cells obscure; appendages usually very numerous, densely interwoven, rather short, more or less vaguely branched, colorless or brown, sometimes very short or even obsolete; asci 7–38, usually about 20, large, from narrowly cylindrical to ovate, usually longly pedicellate, 75–110 (usually about 90) $\times$ 28–40 μ; spores 2, large, variable in size, usually about 32 $\times$ 18 μ, but varying from 28–40 $\times$ 14–22 μ, sometimes slightly curved.

HOSTS.—*Acanthophyllum glandulosum*, *Alhagi camelorum* (206), *A. maurorum*, *Althaea ficifolia*, *A. kurdica*, *Arctium minus*, *Artemisia Dracunculus*, *Astragalus* sp., *Capparis spinosa*, *Carduus crispus* (132), *Carlina corymbosa*, *C. lanata*, *Carthamus lanatus*, *Carinthe major* (214), *Chondrilla juncea*, *Cicer songaricum* (206), *Clematis songarica*, *Cnicus arvensis* (214), *C. cardunculus*, *C. lanceolatus* (55) (132), *Coccinea dubia* (206), *Cynara cardunculus*, *Daucus maximus*, *Diarthron vesiculosum* (206), *Dorycinum herbaceum* (214), *Elaeoselinum Lagascae*, *Eryngium campestre*, *E. Noëanum* (233), *Euphorbia lanata*, *Exochorda Alberti* (19), *Foeniculum vulgare*, *Gundelia Tournefortii*, *Haloxylon ammodendron*, *Haplophyllum Sieversianum* (206), *Hedysarum Falconeri*, *Helianthemum oelandicum*, *Inula nervosa*, *Nepeta podostachys*, *Odontospermum aquaticum*, *Peganum Hamala*, *Phlomis Herba-venti*, *P. tuberosa* (214), *Picris hieracioides*, *Psoralea drupacea*, *Salsola canescens* (233), *Saussurea* (214), *Scutellaria multicaulis*, *Taraxacum montanum*, *Teucrium chamaedrys*, *Thevenotia scabra* (233), *Thymelaea* sp., *Verbascum Blattaria*, *V. phlomoides*, *V. speciosum*, *Vicia tenuifolia*, *Zygophyllum Fabago*.

Distribution.—EUROPE: France, Spain, Italy, Greece, Germany, Austria-Hungary, Russia.

AFRICA: Algeria.

ASIA: Turkey, Syria, Persia, Turkestan, India.

E. taurica has been much confused with both *E. cichoracearum* and *E. polygoni*. From the latter species the very numerous regularly bisporous asci at once distinguish it. From the former it is known by the large size of the asci and spores, and from both by the very large concave or "pezizoid" perithecia. The latter feature, indeed, is so characteristic that it makes *E. taurica* one of the few species of the Erysiphaceae which can be safely determined with the lens.

I am quite convinced that *E. Duriaei* Lév., *E. lanuginosa* Fckl., *E. lichenoides* Trab., and *E. papilionacearum* Kom., all belong to the present species. *E. Duriaei* (on species of *Phlomis*) and *E. papilionacearum* (on *Astragalus*, *Psoralea* and *Cicer*) have been stated to differ from *E. taurica* in having colored appendages; the former, also, in possessing only 8 asci. These characters do not hold good. There is a specimen of *E. Duriaei* in the Kew Her-

barium from Léveillé's herbarium, labelled "Gallia austral. ad fol. *Phlomidis herba-venti*," which is apparently the specimen referred to by Léveillé in his monograph. In this specimen the perithecium contains up to 30 asci. In authentic specimens of *E. papilionacearum*, as well as in the example of *E. Duriaei* mentioned above, the appendages are sometimes colorless, sometimes pale brown, and we find just the same variation in these characters in authentic specimens of *E. taurica* on other hosts. Both plants must be undoubtedly referred to *E. taurica*, and it may be noticed that Komarow (206, p. 39) although giving *E. papilionacearum* specific rank, speaks of the plant as forming a passage from *taurica* to *Duriaei*. *E. lanuginosa*, on *Daucus maximus* from Greece, was originally described by Fuckel as "8–12-spored," and this description has been copied by subsequent authors. Examination of authentic specimens shows however that the asci are constantly bisporous, and the plant, together with that on *Foeniculum vulgare* from Algeria, described by Trabut and Saccardo as *E. lichenoides*, present no distinguishing characters from *E. taurica*.

In the Revue Mycologique for 1889 Sorokine published the following new species of *Erysiphe* from Central Asia (Turkestan); *E. Saxaouli* on *Haloxylon Ammodendron*, *E. armata* on *Malva* sp.; *E. alhagi* on *Alhagi camelorum*, and *E. pegani* on *Peganum Hamala*. I have not been able to see authentic specimens of these plants, but from the descriptions and figures given by Sorokine, I have little hesitation in referring them all to *E. taurica*. I have seen an *Erysiphe* (representing probably *E. pegani* and *E. Saxaouli*) on *Peganum Hamala* and *Haloxylon Ammodendron* from Turkestan, which is certainly *E. taurica*; as regards *E. alhagi* Komarow reports *E. taurica* on *Alhagi camelorum*. Komarow (206, p. 275), who has collected since in the same region as Sorokine did, has already expressed the opinion that these three species were founded on immature examples of *E. taurica*.

Since the above notes were written, Magnus (233) has published as new species, under the names of *Erysiphe lanata* and *Microsphaera Bornmuelleriana*, two plants occurring respectively on *Euphorbia lanata* and *Acanthophyllum glandulosum*, collected by Bornmüller in Persia. Both these plants I refer to *E. taurica*.

E. lanata is thus described: "Diese schöne *Erysiphe* bildet

einen dichten weissen filzigen Mehlthau auf der *Euphorbia lanata* Sieb. Die Perithecien haben 120–150 μ Durchmesser; sie haben nur an der Basis ganz kurze, flockige, hyaline Appendiculae von der Länge etwa eines Drittels des Durchmessers der Perithecien; diese enthalten sehr zahlreiche Asci, 20 und mehr. Der Ascus enthält drei oder vier oder auch fünf Sporen (mehr habe ich nicht gesehen, könnten aber recht wohl auftreten). Die Ascosporen sind oval, 27 μ lang und 13.5 μ breit."

I am indebted to Professor Magnus for kindly sending me the type specimens of *E. lanata* and *M. Bornmuelleriana* for examination.

The size of the perithecia of *E. lanata* is somewhat larger than that given in the description, as in mature examples it is usually 190–210 μ. The asci, also, appear to be constantly bisporous. In some of the unripe asci there are, besides the two young spores, one or two drops of oily matter; in the ripe ascus, however, only 2 large spores were observed. If more than 2 spores do occur, it is certainly only very rarely; and in the habit, large perithecia, with very numerous large asci the plant on *Euphorbia lanata* agrees perfectly with *E. taurica*. On looking over the specimens of *Euphorbia lanata* in the Kew Phanerogamic Herbarium, I found plants, on three sheets, more or less covered with the present fungus. The first plant came from Persia, "prov. Tarsistan, ad. Persepolis, c. 1600 m. s. m." (Bornmüller, Iter Persico-turcicum 1892–3, 4675); the two others from Syria, one labelled "Reliquiae Mailleanae no. 1675"; the other collected by Sir J. D. Hooker and Mr. D. Hanbury in 1860. There is also a fungus in the Kew Herbarium labelled "*S. Castagnei* ad. *Euphorb.* sp. nr. Kellal, 10,000 Pers. austr. (Prof. C. Haussknect, Iter orientale, 1868)." This proves on examination to be *E. taurica*, and is apparently the same plant as that to which Magnus (233, p. 100) refers.

M. Bornmuelleriana is thus described: "Diese schöne *Microsphaera* ist durch den Charakter ihrer Appendiculae sehr ausgezeichnet. Der Durchmesser der Perithecium schwankt von 147–231 μ, ist durchschnittlich 197 μ. Sie sind an ihrer Basis von einem dichteren Kranze von Appendiculae umgeben, deren Höhe etwa die den Durchmesser der Perithecien erreicht. Die Appendiculae sind in

der für *Microsphaera* charakteristischen Weise zwei bis drei Male dichotom oder trichotom getheilt und ihre letzten Enden sind zart und lang schlauchförmig verlängert, wie das auch bei der nordamerikanischen *Microsphaera Van-Bruntiana* Ger. auf *Sambucus Canadensis* der Fall ist. Während aber bei allen anderen *Microsphaera*-Arten, die ich kenne, die Appendiculae einzeln frei von einander vom Perithecien abstehen, verflechten sie sich hier zu einem dichten Filze mit einander, der die Basis des Peritheciums umgibt und die Perithecien etwa emporhebt. Während sonst die Verzweigungen der wiederholt dichotom getheilten Appendiculae von *Microsphaera* starr sind, bleiben eben hier die langen schlauchförmigen Endzweige der Appendiculae zart und hyalin, und verflecten sich etwas gekräuselt durch einander. Die Perithecien enthalten zahlreiche Asci. Im Ascus wurden 4–6 Sporen beobachtet, manchmal in einem Ascus zwei grosse und zwei kleine, offenbar abortirende Sporen. Die Ascosporen sind oval, etwa 30 μ lang und 19 μ breit."

This plant is certainly not a *Microsphaera*, but belongs to *Erysiphe*, and in my opinion cannot be separated from *E. taurica*. It has no points of resemblance whatever with *Microsphaera Van-Bruntiana* (*M. grossulariae*). The branching of the much-interwoven appendages is quite vague and ill-defined, and similar to that found in *E. taurica* on other hosts. Even in "*M. Bornmuelleriana*" the appendages are not by any means always 2–3 times di-trichotomous, but are frequently only once or twice vaguely branched (see Figs. 145, 146, 147). Just the same kind of vague branching is found in some appendages of "*E. lanata*" on *Euphorbia* (see Fig. 148). Further, in all the perithecia which I have examined, the asci are bisporous, and the whole habit of the plant, the large "pezizoid" perithecia, large asci and spores, etc., are quite characteristic of *E. taurica.*

Erysiphe intertexta Berk. mss. in Herb. Kew on *Capparis* sp., "between Lama Yara and the Phatu Pass, 1848, Dr. Thomson," is *E. taurica.*

In mycelial characters *E. taurica* is extremely variable, and there is no doubt that it is partly due to this fact that the species has been described under so many different names. When persistent, the mycelium varies from felted tomentose to crustaceous

or lichenoid; its color is usually white, but sometimes (as on *Capparis herbacea*, *Clematis songarica*) it shows here and there patches of a pale buff color, at these spots the mycelium somewhat resembles thin washleather. Sometimes, however, the mycelium is completely evanescent, as Léveillé, indeed, pointed out in 1851. We sometimes find on a plant whose leaves are for the most part entirely covered with densely compacted persistent mycelium, some leaves here and there on which there is no trace of mycelium, the perithecia occurring quite naked on their surface; also on some plants which have a dense covering of stellate hairs on the leaves (*e. g.*, *Verbascum Blattaria*, *V. phlomoides*, *Phlomis Herba-venti*) the mycelium is apparently never persistent.

The persistent mycelium and large subimmersed perithecia give to *E. graminis* an external resemblance to the present species, but *E. taurica* is most closely allied to *E. cichoracearum;* indeed, occasionally certain forms of the latter species on *Arctium* show a slight approach towards *E. taurica*.

Komarow (206, p. 277) notes that in Seravschan (Turkestan) at the height of 6,000 feet *E. taurica* is one of the most widely-spread species, up to 4,000–5,000 feet, occurring on almost all the plants of the steppes, but that higher than 6,000 feet the fungus does not occur, although several of its hosts ascend to a higher altitude.

E. taurica has been reported from Asiatic Siberia on *Achillea Ptarmica*, but the specimens I have seen from there all belong to *E. cichoracearum*. Léveillé (214, p. 162) gives *Cnicus eriophorus* as a host-plant for *E. taurica*, but a specimen so named in Léveillé's handwriting in Montagne's herbarium, on this host, is *E. cichoracearum*.

The conidia of *E. taurica* are very large; in examples on *Euphorbia* and *Acanthophyllum* they frequently measure 50 × 18 μ.

7. E. AGGREGATA (Peck) Farl. [Fig. 144].

Erysiphella aggregata Peck, Reg. Rep. **28**: 63. *pl. 2. f. 1–3.* 1875; Sacc. Syll. Fung. **1**: 23. 1882.

Erysiphe aggregata (Peck) Farl. Bull. Buss. Instit. **2**: 227. 1878; Burr. Ell. and Everh. N. Amer. Pyren. 14. 1892.

EXSICC. Seym. & Earle, Econ. Fung. 168; de Thuem. Myc.

Univ. 753, 754, *Ell. & Everh. Fung. Columb. 222; Ell. & Everh. N. Amer. Fung. 2763.

Amphigenous; mycelium evanescent or here and there persistent, at first white becoming yellowish, perithecia more or less densely gregarious, sometimes very crowded and forming a crust-like covering, globose-depressed, variable in size, 130–230 μ in diameter, usually about 180 μ; cells 10–15 μ wide, usually 10 μ, often obscure; appendages numerous, densely interwoven, from equaling to 2–4 times exceeding the diameter of the perithecium, colorless or rarely pale yellowish-brown in the lower half, more or less branched, irregularly swollen and bent at intervals, at first thin-walled and septate, becoming thick-walled towards base; asci numerous, usually about 20, but sometimes as many as 42, from ovate-oblong to more or less cylindrical, large, 80–115 × 30–40 μ; spores 8, rarely 7, very rarely 6, somewhat roundish, 16–20 × 10–15 μ, usually about 18 × 12 μ.

Host.—On female catkins of alder; *Alnus incana*, *A. serrulata*, *A. viridis*.

Distribution.—NORTH AMERICA: United States—New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Canada, New Brunswick, Ontario.

Peck (279, p. 63) originally published the present species as the type of a new genus, with the following description: "*Erysiphella* nov. gen., perithecia destitute of appendages, spores definite. This genus differs from *Perisporium* in having a definite number of spores in an ascus, and from *Uncinula*, *Microsphaera* and *Erysiphe* in being destitute of appendages."

The present species really possesses, however, as Farlow (123) has already pointed out, very numerous appendages, and is certainly to be referred to the genus *Erysiphe*. The appendages are more or less densely interwoven, forming usually a pulvinate mass at the base of the perithecium, and are somewhat easily broken off, so that often on quite old perithecia only the broken ends are to be found, or sometimes even these are not to be seen.

Although distinct in its curious habitat on the female catkins of alders, *E. aggregata* morphologically must be considered very close to *E. polygoni*, from which it differs only in the large perithecia, and larger, more numerous, subcylindrical asci. The eight roundish spores give a characteristic appearance at first sight to *E. aggregata*, but just the same shaped spores are found in the in-

teresting form (occurring on young twigs of *Alnus incana* in Finland) published as a distinct species, *E. vernalis*, by Karsten, but which I have felt compelled to regard as only a form of *E. polygoni*. *E. aggregata* can be separated from this form on the twigs of *Alnus* in Europe only by the larger average size of the perithecia and asci, and the greater number of the latter—characters of not very high specific importance. It is quite possible, I think, that *E. aggregata* may have to be considered only a well-marked variety of *E. polygoni*, rather than a distinct species. Valuable evidence on this point might perhaps be obtainable from the experiment of sowing conidia of *E. aggregata* on host plants of *E. polygoni*, or conversely by infecting alder catkins with the conidia of *E. polygoni*.

8. E. TRINA Harkn. [Figs. 141, 142]

Erysiphe (*Erysiphella*) *trina* Harkn. Bull. Calif. Acad. Sci. **1** : 41. 1886 ; Sacc. Syll. Fung. Addit. ad Vol. I.–IV.: 3. 1886 ; **9** : 370. 1891 ; Burr. in Ell. & Everh. N. Amer Pyren. 14. 1892.

EXSICC.: Ell. & Everh. N. Amer. Fung. 2337 ; * Ell. & Everh. Fung. Columb. 23.

Epiphyllous ; mycelium persistent, effused or forming irregular patches ; perithecia minute, at first yellow, becoming yellowish-brown, globose, more or less gregarious, small, 52–60 μ in diameter, averaging 55 μ, cells at first evident, 8–10 μ wide, soon becoming indistinct as the wall becomes semi-transparent ; appendages usually 3 or 4, short and very rudimentary, sometimes apparently absent ; asci 3, very rarely 2, brodly ovate to subglobose, with or without a minute stalk, 48–50 × 28–36 μ ; spores 2, large, sometimes slightly curved, 25–34 × 14–16 μ.

Host.—*Quercus agrifolia*.

Distribution.—NORTH AMERICA : United States—California.

E. trina is a very marked and interesting species, only known at present from California, on the single host-plant *Quercus agrifolia*. The perithecia are very small, and yellowish-brown at maturity ; the outer wall is very thin, membranaceous, and semitransparent, so that the outline of the large spores is clearly visible in the unopened perithecium (see Fig. 141). Although described as without appendages, there are usually a few rudimentary ones present at the base of the perithecium.

Sub-family PHYLLACTINIEAE Palla.

Mycelium not sending haustoria into the epidermal cells of the host plant, but forming special branches of limited growth, which pass through the stomata into the intercellular spaces of the leaf. Each of these intercellular hyphae sends a single haustorium into the cells of the surrounding tissue (spongy parenchyma).

One genus, *Phyllactinia.*

PHYLLACTINIA Lév. Ann. sci. nat. III. **15**: 144. 1851.

Perithecia large, globose-depressed to lenticular, asci many, 2- or rarely 3-spored. True appendages equatorial, rigid, acicular, with a bulbous base; apex of perithecium provided with a mass of densely crowded branched outgrowths from the epidermal cells. Etym. *φυλλον*, *folium*, and *ακτις*, *radius*. Distrib. Europe, Africa, Asia, North, South and Central America.—1 species.

Phyllactinia is known at once by the large perithecia and the rigid colorless acicular appendages with a bulbous base.

PHYLLACTINIA CORYLEA (Pers.) Karst. [Figs. 163–175]

Sclerotium Erysiphe Pers. Obs. Myc. **1**: 13 (partim). 1796.

S. Erysiphe β corylea Pers. Syn. Fung. 124. 1801; Alb. & Schwein. Consp. Fung. Lusat. 76. 1805.

S. suffultum Rebent. Prod. Fl. Neomarch. 360. *pl. 3. f. 14.* 1804.

Erysiphe coryli Hedw. f. ex DC. Fl. Fr. **2**: 272. 1805.

E. fraxini DC. Fl. Fr. **2**: 273. 1805.

Dematium Erysiphe Spreng. Fl. Hal. 387. 1806.

Erysiphe alni DC. Syn. Pl. Fl. Gall. 57. 1806; DC. Lam. Enc. Méth. (Bot.) **8**: 219. 1808; DC. Fl. Fr. **6**: 104. 1815.

E. oxyacanthae DC. Secret. Mycogr. Suisse, **3**: 655 (syn. excl. partim). 1833; Cast. Cat. Pl. Mars. 190. 1845.

E. betulae DC. Fl. Fr. **6**: 107. 1815; Duby, Bot. Gall. **2**: 870. 1830.

E. varium Fr. Obs. Myc. **1**: 206 (partim). 1815; **2**: 366 (partim). 1818.

E. varium, var. *suffultum* Fr. Obs. Myc. **1**: 206. 1815.

E. vagans Biv. Bern. Stirp. rar. Sic. man. **3**: 19. *pl. 4. f. 3.* 1815.

Erysibe pachypus Mart. Fl. Crypt. Erlang. 393. 1817.

E. suffulta (Reb.) N. v. Esenb. Syst. Pilz. Schw. 148. *pl. 14. f. 134.* 1817; Ueberbl. des Syst. 38. 1817.

Alphitomorpha guttata Wallr. Berl. Ges. Nat. Freund. Verhand. **1**: 42 (excl. syn. *E. salicis* DC.). 1819; Wallr. Ann. Wett. Ges. **4**: 245 (excl. syn. *E. salicis* DC.). 1819; Wallr. Fl. Crypt. Germ. **2**: 760. 1833.

Erysibe orbiculatus Ehrenb. N. Act. Acad. Leop. Car. Nat. Cur. **10**: 203. *pl. 12.* 1821; Lk., Willd. Sp. Pl. **6**: 115. 1824.

E. alni DC., Gray. Nat. Arr. Brit. Pl. **1**: 589. 1821.

E. guttata, var. *fagi* (Wallr.) Ficin. and Schub. Fl. Gegend. Dresd. **2**: 305. 1823.

E. guttata Lk., Willd. Sp. Pl. **6**: 116. 1824; Rabenh. Deutschl. Krypt. Fl. **1**: 234. 1844.

Erysiphe guttata Fr. Syst. Myc. **3**: 245. 1829; Duby, Bot. Gall. **2**: 871. 1830; Berk., Sm. Engl. Fl. **5**: 327. 1836; Tul. Sel. Fung. Carp. **1**: 194. *pl. 1.* 1861; de Bary, Beitr. Morphol. Phys. Pilz. 1, § XIII. 52. 1870.

E. detonsa Fr. Syst. Myc. **3**: 247. 1829.

E. mali Duby, Bot. Gall. **2**: 869. 1830.

E. fagi Duby, Bot. Gall. **2**: 871. 1830.

E. abnormis Duby, Bot. Gall. **2**: 871. 1830.

E. roboris Gachet, Act. Soc. Linn. Bord. I. **5**: 227. 1832.

Alphitomorpha lenticularis Wallr. Fl. Crypt. Germ. **2**: 759. 1833.

Erysibe coryli Wahlb. Fl. Suec. **2**: 1086. 1833.

Erysiphe lenticularis Kickx, Fl. Crypt. Env. Louv. 139. 1835.

E. quercus Mér. Rev. Fl. Par. 459. 1843.

Erysibe lenticularis Rabenh. Deutschl. Krypt. Fl. **1**: 234. 1844.

Erysiphe nivea Cast. Cat. Pl. Mars. 190. 1845.

E. pyri Cast. Cat. Pl. Mars. 190. 1845.

E. ilicis Cast. Cat. Pl. Mars. 191 (syn. excl.). 1845.

E. cerasi Cast. Cat. Pl. Mars. 191. 1845.

Erysibe lenticularis, var. *carpini* Desmaz. Ann. sci. nat. III. **3**: 361. 1845.

Erysiphe aceris Westend. Herb. Crypt. Belg. nr. 551 (cum diag.).

E. marissalii Westend. Bull. Acad. Roy. Belg. **18**: 403. *pl. 1. f. 4.* 1851.

E. guttata, var. *mespili* Cast. Supp. Cat. Pl. Mars. 53. 1851.

Phyllactinia guttata Lév. Ann. sci. nat. III. **15**: 144. *pl. 7. f. 11.* 1851; Cooke, Micr. Fung. 218. *pl. 11. f. 219, 220.* 1865; Cooke, Handb. Brit. Fung. **2**: 646. *f. 313.* 1871; Karst. Myc. Fenn. **2**: 197. 1873.

P. Candollei Lév. Ann. sci. nat. III. **15**: 150. *pl. 7. f. 12.* 1851; Sacc. Syll. Fung. **1**: 5. 1882.

P. suffulta (Reb.) Sacc. Mich. **2**: 50. 1880; Sacc. Syll. Fung. **1**: 5. 1882; Oudem. Rev. Pyren. 11. 1884; Wint., Rabenh. Krypt. Fl. Deutschl. **1**[2]: 42. 1884; Burr. & Earle, Bull. Ill. State Lab. Nat. Hist. **2**: 411. *f. 6.* 1887; Speg. Fung. Pat. 34. 1887; Atkins. Journ. Elisha Mitch. Soc. **7**: 68. *pl. 2.* 1891; Burr., Ell. & Everh. N. Amer. Pyren. 20. *pl. 3.* 1892; Schroet., Cohn's Krypt. Fl. Schles. **3**: 246. 1893; Jacz. Bull. l'Herb. Boiss. **4**: 736. 1896; Oudem. Rév. Champ. Pays.-Bas, **2**: 85. 1897.

P. corylea (Pers.) Karst. Act. Soc. Faun. Fl. Fenn. **2**: 92. 1885.

P. antarctica Speg. Fung. Pat. 34. 1887; Sacc. Syll. Fung. **9**: 366. 1891.

P. suffulta, var. *macrospora* Atkins. Journ. Elisha Mitch. Soc. **7**: 68. 1891.

Erysiphella Carestiana Sacc. Malpighia, **11**: 282. 1897; Sacc. Syll. Fung. **14**: 463. 1899.

Phyllactinia berberidis Palla, Bericht. Deutsch. Botan. Gesell. **17**: 65. *pl. 5.* 1899.

Exsicc. Bri. & Cav. Fung. par. 11, 170; Rab. Fung. Eur. 166, 440, 1052, 1053, 1054, 1055, 1056, 1148, 1519, 2028; Sacc. Myc. Ven. 67, 620, 621, 622, 623, 624, 625, 894, 895, 1377; Fckl. Fung. Rhen. 702, 703, 704, 705, 706, 707, 708, 709, 710, 764; de Thüm. Fung. austr. 124, 124b, 125, 126, 127, 128, 129, 445, 446, 855; Rav. Fung. Amer. exsicc. 85, 86, 623, 624; Roumeg. Fung. gall. exsicc. 1071, 1570, 2418, 2449, 2734, 3520, 3737, 4756; Cooke, Fung. Brit. Exsicc. *92, 598; ed. sec. 598; de Thüm. Myc. univ. 157, 158, 1939; and 846 sub *Microsphaera penicillata;* Oudem. Fung. Neerl. Exsicc. 162, 163; Rab. Herb. myc. ed. 2, 461, *462, 463; Lib. Pl. Crypt. Ard. fasc. 1, 82; Westend. Herb. Crypt. Belg. 413, 658, 739; Kunze, Fung. select.

exsicc. 59, 235; Desmaz. Pl. Crypt. Fr. ed. 1, ser. 1, 167, 1307, 1308, 1519, 2199, 2200, *ed. 2, ser. 1, 112, 707, 708, 1019, 1849; Syd. Myc. March. 239, 245, 433, *3673, *3723; Jack, Lein, u. Stizenb. Krypt. Bad. 247, 555; Rab.-Wint. Fung. Eur. 3047, 3048, 3049; Baxt. Stirp. Crypt. Oxon. fasc. 2, 96; Fl. Exsicc. Austr.-Hung. 381; Roumeg. Fung. Select. Gall. Exsicc. 260; Ell. N. Amer. Fung. 1327; Berk. Brit. Fung. 205; Moug. and Nestl. Stirp. Crypt. Vosges, 83; Vize, Fung. Brit. 92; Fl. Gall. et Germ. Exsicc. 1200; Rehm, Ascom. 797; Wint. Fung. helvet. Supp. 86, 87 (in Herb. Earle); *Seym. and Earle, Econ. Fung. 142, 143, 153, 177; *Erikss. Fung. par scand. 139a, 139b; *Kneiff. and Hartm. Pl. Crypt. Bad. 56, 162; *Funck, Crypt. Gewäch. Fichtenb. 123; *Wartm. and Schenk, Schweiz. Krypt. 14, 422, 423; Erb. Critt. Ital. ser. 1, *191, *594; et 591 in Herb. Mus. Florence; *ser. 2, 836, 837; *Hoppe, Fung. Epiph. 15, 16; *Wartm. and Wint. Schweiz. Krypt. 724, 823; Klotzsch, Herb. Myc. 180 (in Herb. Upsala Mus.); *Wagn. Crypt. Herb. Biel. 10; *Gandog. Fl. Alger. exsicc. 1982; *Romell. Fung. exsicc. praes. scand. 61; *Ell. and Everh. Fung. Columb. 108.

Usually hypophyllous, very rarely amphigenous; mycelium often evanescent, but sometimes more or less persistent, and then thin and effused, or rarely forming definite patches; perithecia usually scattered, but sometimes gregarious, large, globose-depressed to lenticular, 140–270 μ in diameter, or rarely reaching to 350 μ in diameter, cells rather obscure, 15–20 μ wide, apex of perithecium provided with a mass of densely crowded special outgrowths from the external cells, each outgrowth when mature terminating in a fascicled head of numerous short hyphal branches, which, when the perithecium becomes turned over, grow more or less mucilaginous and fix the perithecium upside down to the substratum; true appendages equatorial, usually from 5–18, occasionally as many as 25, 1–3 times the diameter of the perithecium, acicular, rigid, straight or occasionally slightly flexuose towards the apex, aseptate, colorless or very rarely yellowish-brown at the apex, swollen at the base into a hollow bulb; asci 5–45, subcylindrical to ovate-oblong, 60–105 × 25–40 μ, very rarely as large as 120 × 50 μ, more or less stalked; spores 2, rarely 3 (4 recorded by some authors), variable in size, sometimes curved or rather irregular in shape and larger at one end than at the other, 30–42 μ, rarely reaching to 50 μ, × 16–25 μ, when 3, smaller, about 24 × 14 μ.

Hosts.—*Acer campestre* (214) (263) (272) (387), *A. platanoides* (272), *A. Pseudo-Platanus*, *A. saccharinum* (97), *Actinidia arguta*, *Alnus glutinosa*, *A. glutinosa* × *incana*, *A. incana* and var. *virescens*, *A. maritima*, *A. rubra*, *A. serrulata*, *Amelanchier Canadensis*, *Anarthrophyllum rigidum* (336), *Angelica sylvestris*, *Artemisia vulgaris*, *Asclepias Syriaca* (280), *Berberis vulgaris*, *Betula alba*, *B. lutea* (153), *B. nana*, *B. nigra*, *B. occidentalis*, *B. papyracea*, *Broussonetia papyrifera*, *Buxus sempervirens* (41), *Carpinus Americana*, *C. Betulus*, *Carya* sp. (97), *Castanea dentata* (249), *C. sativa* and var. *Americana*, *Catalpa bignonioides*, *C. speciosa*, *Celastrus scandens*, *Cephalanthus occidentalis*, *Chelone glabra* (324), *Chionanthus Virginica* (214) *Clematis Vitalba* (130), *Colliguaja Brasiliensis* (335), *Cornus Amomum*, *C. candidissima* (280), *C. circinata* (280), *C. florida*, *C. Mas*, *C. Nuttallii*, *C. sanguinea*, *C. stolonifera*, *Corylus Americana*, *C. Avellana* and var. *laciniata*, *C. Colurna*, *C. rostrata*, *C. tubulosa*, *Cotoneaster* sp., *Crataegus coccinea*, *C. Crus-galli* (280), *C. occidentalis*, *C. Oxyacantha*, *C. rivularis*, *C. sanguinea* (349), *C. tomentosa* and var. *pyrifolia*, *Desmodium Canadense* (60), *Elsholtzia* (273), *Erythrina* sp., *Euonymus Europaeus* (22), *Fagus ferruginea* (61) (97) (280) (324), *F. sylvatica*, *Fragaria* sp., *Fraxinus Americana*, *F. excelsior* and var. *diversifolia*, *F. Mandshurica*, *F. Ornus*, *F. oxyphylla* (214), *F. pubescens*, *F. quadrangulata*, *F. sambucifolia*, *F. viridis*, *Hamamelis Japonica*, *H. Virginiana* (97) (153) (163), *Heuchera parvifolia* (6), *Hippophaë rhamnoides*, *Humulus Lupulus* (230), *Ilex decidua*, *Juglans* (130), *Liriodendron Tulipifera*, *Lonicera Caprifolium*, *L. Xylosteum*, *Magnolia acuminata* (280), *M. Fraseri* (249), *M. Kobus*, *Mercurialis perennis*, *Morus alba*, *Negundo aceroides* (151), *Nyssa* sp., *Olea Europaea* (41), *Ostrya Virginica*, *Paliurus aculeatus*, *Parmentiera alata*, *Paulownia imperialis*, *Philadelphus Lewisii*, *Prunus Americana* (371), *P. Avium* (214), *P. Cerasus*, *Pyrus amygdaliformis*, *P. communis*, *P. Germanica*, *P. torminalis* (214), *Quercus aquatica*, *Q. Catesbaei*, *Q. coccifera* (396), *Q. coccinea* and var. *tinctoria*, *Q. discolor*, *Q. falcata*, *Q. Ilex*, *Q. Kelloggii*, *Q. macrocarpa*, *Q. nigra*, *Q. palustris*, *Q. Phellos* (12) (371), *Q. Robur*, *Q. rubra*, *Rhamnus alpina*, *Rhododendron* (*Azalea*) sp., *Ribes Cynosbati*, *R. Grossularia*, *R. Magellanicum* (336), *Rubus fruticosus* (3) *Salix* sp., *S. Caprea* (214), *Sambucus* sp. (130), *S. nigra* (214) (293) (316), *Syringa vulgaris* (290),

Tanacetum vulgare, Typha latifolia (5), *Ulmus alata, U. Americana, U. campestris, U. montana, Vaccinium stamineum, Vitis Labrusca* (36), *Xanthoxylum Americanum.*

Distribution.—EUROPE: Britain, France, Portugal (396), Belgium, Netherlands, Germany, Switzerland, Italy, Austria-Hungary, Denmark, Norway, Sweden, Finland, Russia.

AFRICA: Algeria.

ASIA: Turkey (Aleppo), Transcaucasia (338), Siberia (Minussinsk) (235), China (Yun-nan) (273), Japan.

SOUTH AMERICA: Paraguay (335), Patagonia (336), Tierra del Fuego (337).

CENTRAL AMERICA: Guatemala.

NORTH AMERICA: Mexico; United States—New Hampshire, Massachusetts, Connecticut, New York, Pennsylvania, West Virginia, South Carolina, Ohio, Michigan, Indiana, Alabama, Illinois, Mississippi, Wisconsin, Missouri, Iowa, Minnesota (325), South Dakota (151), Kansas (386), Montana, Wyoming, California, Washington; Canada—Ontario, Newfoundland.

Phyllactinia corylea is the most sharply characterized and one of the most widely spread species of the Erysiphaceae. The large size of the perithecium, and the acicular appendages with a bulbous base, enable the present species to be easily recognized, usually with the naked eye.

Nevertheless, as will be seen from the synonomy, *P. corylea* has had many names given to it. This has been due partly to the fact that the appendages are either very fragile or deciduous, and so the fungus under different conditions has been supposed to belong to different species; for the most part, however, these names owe their origin to the fact that *P. corylea* grows on a very large number of hosts, and in former times the occurrence of a species of mildew on a new host-plant usually led to the description of the fungus as a new species.

There can be no doubt, when sufficient material is examined, that only a single species of *Phyllactinia* exists. Whether on its numerous hosts in America (where Burrill states that "scarcely a deciduous-leafed tree seems proof against it"), whether on *Parmentiera alata* in Guatemala, *Erythrina* in Mexico, on *Morus alba* and *Paulownia imperialis* in Japan, or on the Cupuliferae of Europe,

the variations that occur are never important enough to make us doubt that we are dealing with one cosmopolitan species, able to live not only on a great number of different trees, but also, apparently, on some herbs (see list of host-plants above).

I have united *P. Candollei* Lév., *P. antarctica* Speg., and *P. berberidis* Palla with the present species.

Léveillé described *P. Candollei* from specimens occurring on the leaves of a species of *Nyssa* in North America, and remarked (214, p. 150), "Cette espèce ressemble à la précédente [*P. corylea*]; la seule différence repose dans les sporanges, qui sont au nombre de huit et qui renferment quatre spores au lieu de deux." I have examined two specimens of Léveillé's plant; one in Berkeley's Herbarium at Kew, the other in Montagne's Herbarium in the Paris Museum; both specimens are named in Léveillé's handwriting. Many of the asci in these specimens were found to be 2-spored (in one perithecium all the asci were bisporous), but most contained 3 spores; I did not observe 4 spores in any. The asci were frequently above 8 in number, in one case being as numerous as 18; this character, however, is not important, as there are often less than 8 asci in undoubted examples of *P. corylea.* The two examples showed no other differences, and there is therefore no reason to consider "*P. Candollei*" as more than a mere form of *P. corylea* with frequently 3 (or even, perhaps, sometimes 4) spores in the ascus. It is curious that *Phyllactinia* has not been reported on *Nyssa* since Léveillé's time. The specimen on which Berkeley's record of "*P. Candollei*," from Canada (Poe), in Grevillea, 4: 158. 1876, was based, agrees in every way with *P. corylea.*

I have not been able to see a specimen of *P. antarctica* Speg., found on *Ribes Magellanicum* in Patagonia, but from the description given have no hesitation in referring it to *P. corylea.* Spegazzini records: "*P. suffulta* (Reb.) Sacc. [*P. corylea*] as occurring on *Anarthrophyllum rigidum* from the same region, and gives a good description of the fungus. Speggazzini's diagnosis of *P. antarctica,* however, applies better to the more usual form of *P. corylea* than does his diagnosis of the form of "*P. suffulta*" mentioned above, and there can be no doubt that both specimens are referable to *P. corylea.*

P. berberidis Palla is a very interesting form. In Palla's valu-

able paper mentioned above, the *Phyllactinia* growing on barberry leaves is described as a new species under this name. The author remarks (264, p. 64) that "die *Phyllactinia* der Berberitzenblätter zwar sehr nahe der *P. suffulta* der Haselnussblätter steht, sich aber von ihr *constant* vor allem durch die an der Spitze stark gebräunten Perithecien-Anhängsel unterscheidet und demnach als eine eigene Art anzusprechen ist." At page 56 (loc. cit.) the same character is more closely described: "An ihrer Spitze sind die vollkommen ausgebildeten Anhängsel bei *P. suffulta* ziemlich stark verschmälert und häufig etwas geschlängelt; die *abgestorbenen Plasmareste sind stets farblos* und reichen sehr oft nicht bis in das Ende der zart-wandigen Spitze hinein, an der nicht selten das Anhängsel collabirt erscheint. Bei *P. berberidis* sind die Anhängsel an der Spitze nur wenig verschmälert; *die hier vorhandenen abgestorbenen Plasmareste sind immer mehr minder stark gebräunt* und gehen bis in das Spitzen-ende hinein; meist erstreckt sich die Färbung auf das ganze obere Drittel, und nicht selten reicht sie bis zur Mitte des Anhängsels herab."

The brown color of the protoplasmic contents of the apex of the appendages is probably best seen in living plants; and becomes partly lost in dried material. In the dried specimens (now in the Kew Herbarium) kindly sent to me by Dr. Palla, the apex of the appendages is yellow-brown, and the appendage has the appearance shown at Fig. 171 (*cf. pl. 5. f. 2* of Dr. Palla's article).

The other minor differences described as existing between the perithecia of *P. berberidis* and *P. corylea* certainly do not hold good when dealing with the numerous forms of the latter—as perhaps might be expected from the author's statement that only examples of *P. corylea* occurring on *Corylus* in Austria were taken into consideration in making the comparison.

With regard to the value that should be attached to the presence of the colored tips of the appendages it seems to me very probable that the color is to be considered as wholly due to the influence of the particular host on the fungus. We know that the barberry contains a yellow coloring matter (berberin), and I am inclined to attribute to the effect of this substance on the fungus not only the colored tips of the appendages, but also the very bright yellow color of the asci and spores. With regard to these

highly colored asci and spores there is every appearance of the condition being a pathological one.

On the whole, it appears best to consider the *Phyllactinia* on *Berberis* as a form slightly affected by certain peculiarities of the host-plant, and not morphologically distinct from *P. corylea*.

Dr. Palla is mistaken in stating that *Phyllactinia* had not previously been reported on *Berberis*. Saccardo has distributed specimens from Italy (Sacc. Myc. Ven. 895, *Phyllactinia guttata*, f. *Berberis vulgaris*); Passerini (272), and many other authors have recorded it from other places in Europe, and Berkeley (35), Farlow (122), Burrill (60), etc., report it from America.

Erysiphella Carestiana was described by Saccardo as being destitute of appendages, and consequently referable to the genus named. Professor Saccardo very kindly sent me the type-specimen for examination. The fungus is *P. corylea;* some of the perithecia have lost their appendages, but some show a few perfect ones, and many have retained a ring of the bulbous bases of the appendages. The fungus was recorded as growing on the damp pileus of *Fomes fomentarius*, but there is now every reason, I think, for believing that it did not originate there. Certainly the perithecia adhere firmly to the pileus of the *Fomes*, but there is as regards the present species, clear evidence for disregarding mere attachment as a proof that the fungus originally grew there. Dr. Palla, when sending me specimens of the *Phyllactinia* on *Berberis*, wrote that the fungus was always hypophyllous, and mentioned that the perithecia which were to be found on the upper surface of the leaves sent, owed their presence there to the pressure of the under sides of other leaves. Without such warning, one would certainly have considered these perithecia as originally growing on the upper surface of the leaf, for they were firmly attached to the substratum, and like the specimens on the pileus of the *Fomes* required some little force to move them with a needle.

This reattachment of the perithecium is brought about by the mucilaginous branches of certain special apical outgrowths. In the case of the *Phyllactinia* on the *Fomes*, Professor Saccardo states (52) that the pileus of the "host"-fungus was moist; this favors the idea that a reattachment by means of the mucilaginous branches had taken place. I am glad to be able to state that

Professor Saccardo now agrees with the view that the position of *Phyllactinia* on the *Fomes* is in all probability an accidental one.

Hitherto the presence of attached perithecia on a leaf has naturally been considered as conclusive proof that the fungus originated there, but for the reasons mentioned above, such proof now becomes invalid. It is therefore very desirable that the reported occurrences of *P. corylea* on *herbs* should be investigated in the field, as it is impossible to prove from the examination of herbarium specimens (unless perithecia can be observed springing from a mycelium) if the fungus originated on the plant in question. An observation of Fuckel's (133, p. 80) perhaps refers to this reattachment of perithecia. This author remarks "dass die Perithecien auf in der Nähe stehende Pflanzen, wie Gräser usw. ueberwucherten. Dasselbe mag wohl auch der Fall sein mit jenen, welche Bagge auf *Pertusaria* fand."

Professor Miyabe has sent me specimens (now in the Kew Herbarium) of a very beautiful form of *P. corylea* from Japan, growing on *Paulownia imperialis.* The form is remarkable for its large size. Many of the perithecia reach a diameter of 350 μ; the appendages are more numerous than usual, being sometimes as many as 25, when they are arranged so closely round the perithecium that their bulbous bases touch one another. In these perithecia the asci and spores show, likewise, a tendency to be larger than usual. Intermixed with these large perithecia, however, are others which, in the smaller size of all their parts, agree perfectly in every respect with ordinary *P. corylea.* Altogether, we cannot consider that the *Phyllactinia* on *Paulownia* is anything but a luxuriant form of *P. corylea*, which it would be inadvisable to separate even as a variety. It is most probable that further search on other Japanese plants would bring to light a complete series of forms of *Phyllactinia* intermediate in size between this large form on *Paulownia* and those of normal size.

Since writing the above, I have noticed that Atkinson (9) has described a form of *Phyllactinia* occurring on certain American oaks (*Quercus Phellos, Q. nigra*) as variety *macrospora.* The form, from the description, is evidently comparable to the Japanese plant mentioned above. The perithecia, apparently, are not so large (200–250 μ in diameter), but the very large asci, reaching

to 120 × 50 μ, and spores 35–50 μ long, are similar to those of the Japanese form. Both, I feel convinced, are to be considered as merely large forms of *P. corylea*, quite unable to be separated systematically.

Erysiphe detonsa Fries is, in all probability, the present species, as Léveillé has contended (214, p. 145). In the Friesian Herbarium there is a specimen named "*E. detonsa*" in Fries' handwriting, and this is certainly *P. corylea*. This specimen occurs on the wood of *Fraxinus*, however, and is, therefore, not the type which is described in Syst. Myc. as growing on *Tanacetum vulgare*. I have seen the specimens on *Tanacetum vulgare* (in Montagne's Herbarium at the Paris Museum), which Léveillé has stated came from the same source as those on which Fries founded his species, and find that these also belong, as Léveillé has said, to *P. corylea*. It is true Fries says of his plant "peridiolo solitario"; with the exception of this character, however, the description applies well to imperfect examples of *P. corylea*, and it is to be noted that Fries says "Peridia . . . facie *E. guttatae*." The fungus identified by Kickx as Fries' *E. detonsa* is the *Sphaerotheca* called *S. humuli*, var. *fuliginea* (see Sacc. Syll. Fung. **1**: 4; also Oudem. Rév. Champ. Pays-Bas, **2**: 84–85.

In the description of *P. corylea* above it is mentioned that the perithecia possess a mass of special apical outgrowths. The nature of these outgrowths has been until quite recently completely misunderstood. Each outgrowth, which springs from the external face of a cell of the outer wall of the perithecium, consists of a stalk-cell (Fig. 173, *a*), bearing a terminal mass of densely-clustered, short, swollen, more or less tubular branches (Fig. 173, *b*). Sometimes the stalk cells branches irregularly before giving rise to the branches. At a certain stage of development, the branches of each outgrowth become mucilaginous, and their separate walls more or less indistinguishable (Fig. 174, *a*). In this mucilaginous condition, the outgrowths which arise in a dense mass from the apical cells, cause the firm attachment of the perithecium to the substratum. During the process of this mucilaginous degeneration, the walls of the hyphal branches become more or less dissolved and are invisible without staining, while the protoplasmic contents of each branch remain distinct, especially toward the apex (Fig. 175); at

this stage each outgrowth has much the appearance of a stem-cell bearing a number of stalked spores. An interesting point in connection with these apical outgrowths is the power they possess, after the perithecium on which they occur has been detached from its original substratum, of again becoming mucilaginous and so causing the reattachment of the perithecium to foreign objects. As mentioned above, the occurrence of *P. corylea* on the pileus of *Fomes fomentarius* is probably to be accounted for in this way, and the same explanation is perhaps to be given to many of the recorded cases of the occurrence of *P. corylea* on herbaceous plants.

The explanations given of the apical outgrowths by previous authors have been very different. Nägeli (256) described the structures as a parasitic fungus under the name of *Schinzia penicillata* (afterwards changed to *Naegelia penicillata* by Rabenhorst) Bonorden (49) stated that they were part of the fungus, but that they sprang from the inner wall of the perithecium and surrounded the asci. Tulasne (369 and 370) fully described the outgrowths, and placed these structures on the organic apex of the perithecium (see 370, *tab. 1*). Vŭillemin (379) repeated Bonorden's error of supposing that the structures originated internally.

Quite recently, however, Neger (258) has published a preliminary note on *Phyllactinia*, in which the author attributes to the outgrowths the function of anchoring the perithecium to the leaf; the conclusion to which I had already arrived from the study of a large amount of herbarium materials from all parts of the world (see Journ. of Botany (314), where a more complete account of the views of previous authors on the nature of the outgrowths is given). In this article I stated that the penicillate cells spring from the *base* of the perithecium. In a paper by Dr. Neger (Bericht. Deutsch. Botan. Gesell. **17**: 235–242. *pl. 23*. 1900) appearing shortly afterwards, the author, from the study of living specimens, described and figured these outgrowths as springing from the apex of the perithecium. This led me to reëxamine perithecia, with the result that I found Dr. Neger's statement to be perfectly correct. I can only suppose that in the section from which the Fig. 6 (Journ. of Bot.) was drawn, the asci were really loose, and dragged round in the process of cutting. The firm attachment of the perithecium by the outgrowths also led me at that time to

think that the latter sprang from the organic base of the perithecium, whereas as Dr. Neger (*l. c.*) has shown, the perithecium, when so fixed, is really turned upside down. Neger has briefly mentioned that in a *Phyllactinia* from the Argentine examined by him the outgrowths were characterized by a much-branched stalk-cell, and on this account the author regards the fungus as a new species of *Phyllactinia*, and proposes the name *P. clavariaeformis*. As a full description and figures of the plant are promised, the question of its specific distinctness must be left open until these appear, although as I have already pointed out (314, p. 453. *f. 3*) the validity of the character relied upon seems doubtful.

Richon (298) describes a fungus which attacks the leaves and stems of *Poa nemoralis* and *Festuca sylvatica*, and gives the name "*Erysiphe graminis ?* DC." to the plant, but remarks: "Les périthèces soul ornés de 6 ou 8 appendices, simples et renflés à la base. Il constitue probablement une variété de *Phyllactinia suffulta* non signalée par les auteurs et différente de *l'Erysiphe graminis* de Saccardo." It will be well to ascertain if the *Phyllactinia* was actually growing on the plants mentioned, before adding grasses to the list of the host-plants of the species.

P. corylea is sometimes mentioned among the diseases attacking cultivated nut trees, but I have found no statement that it has ever caused any serious injury. Pammel (268, p. 103) mentions that *Phyllactinia* "occurred destructively on *Fraxinus*," at Ames, Iowa.

Doubtful or Excluded Species

Erysiphe radiosum Fr. Obs. Myc. **1**: 207. 1815 = *Actinonema rosae* (Lib.) Fr.

E. album Fr. *l. c.* No specimen seen.

Alphitomorpha rosarum Wallr. Ann. Wett. Ges. **4**: 238. 1819. No specimen seen. Wallroth gave the following description: "A subiculo subtilissimo fere obsoleto, sporangiis parvis sparsis sphaericis, capillitio obsoleto. Hypophylla in *Rosa cinnamomea*, rarior. Species ob minutiem sporangiorum facile praetervidenda, nec quoque subiculo detegenda, quod cum tomento folii obductum est. Dubiam igitur modo indico." In Fl. Crypt. Germ. **2**: 755. 1833. Wallroth placed it as a variety under "*A. penicillata*."

A. epigaea Wallr. Berl. Ges. Nat. Freund. Verhandl. **1** : 44. 1819; and Ann. Wett. Ges. **4** : 246. 1819. From the description given there is no doubt that this fungus is to be placed outside the Erysiphaceae, as Dietrich (107, p. 343) has already remarked. Karsten (194) considers it the "sclerotium-stage" of *Lanosa nivalis* Fr.

A. epixylon Schlect. Berl. Ges. Nat. Freund. Verh. **1** : 50. 1819. No specimen seen.

Erysibe acariforme (Sow.) Gray, Nat. Arr. Brit. Pl. **1** : 590. 1821 = *Hypoxylon coccineum* Bull.

E. Sowerbii Gray, *l. c.* = *Coprinus radiens* (Desm.) Fr.

Erysiphe Tordylii Chev. Fl. Par. **1**: 380. 1826. On *Tordylium maximum.* No specimen seen; very probably *E. polygoni.*

Erysibe Wallr. Fl. Crypt. Germ. **2** : 198–218. 1833. All the species of this genus belong to the Uredineae (*Uredo, Ustilago, Puccinia, Tilletia*, etc.).

Erysiphe lathyri Mér. Rev. Fl. Par. 459. 1843. On *Lathyrus latifolius.* No specimen seen.

E. saxifragae sibericae Mér. *l. c.* On *Saxifraga Siberica.* No specimens seen.

E. tiliae Mér. *l. c.* On the lime. No specimens seen.

Phyllactinia Schweinitzii Lév. Ann. sci. nat. III. **15** : 150. *pl. 7. f. 13.* 1851; Sacc. Syll. Fung. **1** : 6. 1882. Léveillé made two sections of his genus *Phyllactinia*—one characterized by the bulbous appendages, the other described as possessing "Appendiculae nigrae vesicula basilari destitutae." The latter contained only *P. Schweinitzii*, described as follows: "Hypophylla. Mycelio arachnoideo evanido. Conceptaculis magnis, sparsis, hemisphaericis, demum depressis. Sporangiis . . . sporis . . . appendiculis nigris. Hab. Meudon, ad folia *Quercus sessiliflorae.* Obs. J'aurais dû passer sous silence cette espèce, comme je l'ai fait de beaucoup d'autres dout je n'ai pas vu la fructification, mais je ne le pouvais pas; ses appendicules solides, noires et dépourvues de vésicules à la base lui impriment un caractère particulier qui empêche de la confondre avec aucune autre espèce connue jusqu'à ce jour." Nothing further has been known about this species since Léveillé's time, and I have not been able to find any example among the specimens of Erysiphaceae sent by Léveillé to

various authors. From the description of the appendages the plant evidently does not belong to the genus *Phyllactinia*—very probably not to the Erysiphaceae at all. The diagnosis given, however, is much too incomplete to admit of an identification of the plant, and if, as seems to be the case, no specimens exist, the name should be dropped.

Erysiphe nervisequia Westend. Bull. Acad. Roy. Belg. **21**: 231. 1854. Westendorp's description is as follows: "Subicule nul, peridium punctiforme, très-petit (1/10e de mille de diamètre), globuleux, d'abord orangé, puis brun et enfin noir, luisant, attaché par quelques fibrilles rares au support et contenant un seul péridiole globuleux—Cette espèce, qui forme des lignes pointillées sur les nervures de la feuille . . . se développe sur les deux faces des feuilles du *Stachys palustris*." Namur, Belgium. I have seen specimens from Westendorp's herbarium (as well as others sent to me by Professor Pâque as *Erysiphe communis* var. *labiatarum*), and find that the fungus does not belong to the Erysiphaceae. The perithecia are from 70–80 μ in diameter, rather irregular in shape, but more or less globose-depressed, with a fragile, membranous wall composed of small rather distinct dark brown cells, 4–5 μ wide. The perithecia occur scattered sparingly on both sides of the leaf, and also occasionally in denser patches on the stem. The so-called "péridiole" is in reality a multicellular structure, and is perhaps the separating inner wall of the perithecium. Within this oval or spherical structure, some bodies which resembled very young asci were observed, but none of the material examined was ripe enough to allow of the generic identification of the fungus. It seems probably, however, that the plant will prove to belong to the Eurotieae.

Erysibe andreaeaccarum and *E. chroolepidis* Reinsch. Contrib. Algol. et Fungol. 96 (1874–5) belong to the Algae. Hariot (Journ. de Bot. **3**: 405. 1889) states that the latter species is *Trentepohlia Monilia* de Wildem. (see however, Magnus, 230).

? *Phyllactinia fungicola* (Schulz.) Sacc. Syll. Fung. **1**: 6. 1882. *Erysiphe fungicola* Schulz. Oest. Bot. Zeit. **26**: 58. 1876.

Saccardo gives the following diagnosis: "Peritheciis brunneo-fuscis, sphaericis, 300 μ. diam., subiculo mucedineo stellatim effuso insidentibus; conidiis in hyphis acrogenis brunneis; appen-

dicibus radiatis, basi inflatis; ascis vesicularibus, copiosis, 1–2-sporis; sporidiis ovato-cylindraceis, 4×1.5. Hab. In superficie *Boleti duriusculi* Slavonia.—Videtur *Phyllactiniae* species, sed ob habitationem insuetam dubia. Turning to Schulzer, we find this description: "*Erysiphe fungicola* Schlzr. fand ich gegen Ende Oktober, im Nustarer Walde bei Vinkovce, zerstreut auf der Oberfläche meines *Boletus duriusculus* im erkrankten Zustande. Die Pyrenien sind schwarzbraun, kuglich, dann am Scheitel einsinkend, 0.3 mm. breit. . . . Sie sitzen, jede für sich, auf einen aus strahlenförmigen kürzeren und längeren Hyphen bestehenden Mycelium. Die längeren, unter sich von fast gleicher Grösse, verdicken sich an der Spitze und es entsteht eine einfache oder einmal septirte, braune, später abfallende Conidie oder Chlamydospore, während der Faden selbst ungefärbt ist. Weiter oben gehen vom Pyrenium in geringer Zahl steif-radienförmige an der Basis blasig erweiterte Fulcri mit einfacher Spitze ab. Ihre Länge beträgt beiläufig den doppelten Pyrenium-Durchmesser."

The asci and spores are described as in Saccardo's translation, except that the size of the latter is stated to be 40×15 μ. Although the characters of the occasional septation and the brown color of the spores do not fit *Phyllactinia corylea*, Schultzer's description in other respects seems to point to this species. *P. corylea* has been recorded lately as occurring on the pileus of *Fomes fomentarius*, but in this case the occurrence of the *Phyllactinia* was merely accidental. In the case of "*E. fungicola*," the presence of mycelium and conidia indicate (if these really were in connection with the perithecia) that the fungus originated on the *Boletus*.

Erysiphe? scandens Ernst (Monatsch. Ver. Beförd. Gart. preuss. Staat. 1878: 400)=*Pellicularia Koleroga* Cooke (see Grevillea, 9: 10. 1880).

Microsphaera Bresadolae (Quél.) Bres. in litt., Sacc. Syll. Fung. 9: 368. 1891; *Podosphaera Bresadolae* Quélet in Bresad. Fung. Trid. 25. *pl. 30. f. 2.* 1881. Quélet's description is as follows: "Perithecia globosa, membranacea, superficialia, sparsa, minutissima, late reticulata, e luteolo rufescentia, demum nigricantia, 90 mmm. diam.; appendiculae hyalinae, perithecio duplo majores, apicibus turgidis dichotomo ramosis praeditae; asci subglobosi, 8-spori, mox evanidi, 50 mmm., sporae ovatae, luteolae, echinu-

latae, 15–20 × 12 mmm. Autumno. In pileo *Arrheniae auriscalpium* Fr. in sylvis umbrosis mixtis. Val di Sole. *Podosphaera clandestinae* Lév. affinis." Saccardo gives the same description and adds "ascis . . . in quoque perithecio pluribus. . . . Etsi matrix tam absona, species generis optima videtur." In Quélet's figure a perithecium is shown with appendages which certainly recall those of the genus *Microsphaera*. On the other hand, the echinulate yellowish spores, if these are correctly described, would be anomalous characters. Overlooking these spore characters, the suggestion may perhaps be made that perithecia of some species of *Microsphaera, e. g., M. alni,* may have accidentally become attached to the pileus of the *Arrhenia*. Abbe Bresadola informs me that unfortunately the type specimen is lost.

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EXPLANATION OF PLATES

(Unless otherwise stated, all figures are magnified 400 times)

PLATE 1

Figs. 1–14. *Microsphaera alni*, apex of the appendage in different forms of the species. 1, from a specimen on *Syringa* (American); 2, on *Gleditschia triacanthos* (from the type specimen of "*M. Ravenelii*"); 3, on *Viburnum Opulus* ("*M. penicillata*," from specimen from Léveillé's herb.); 4, 5, 6, on *Cornus alternifolia* (from the type specimen of "*M. pulchra*"); 7, on *Castanea* (American); 8, on *Betula alba* ("*M. Friesii*," from specimen from Léveillé's herb.); 9, 10, on "*erineum*"-galls on the leaf of *Fagus ferruginea* ("*M. erineophila*"); 11, on *Nemopanthes fascicularis* ("*M. Nemopanthis*"); 12, on *Viburnum Lantana* ("*M. Hedwigii*," from specimen from Léveillé's herb.); 13, 14, on *Cephalanthus occidentalis* (from the type specimen of "*M. semitosta*").

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PLATE 2

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PLATE 3

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PLATE 4

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PLATE 5

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PLATE 7

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Plate 9

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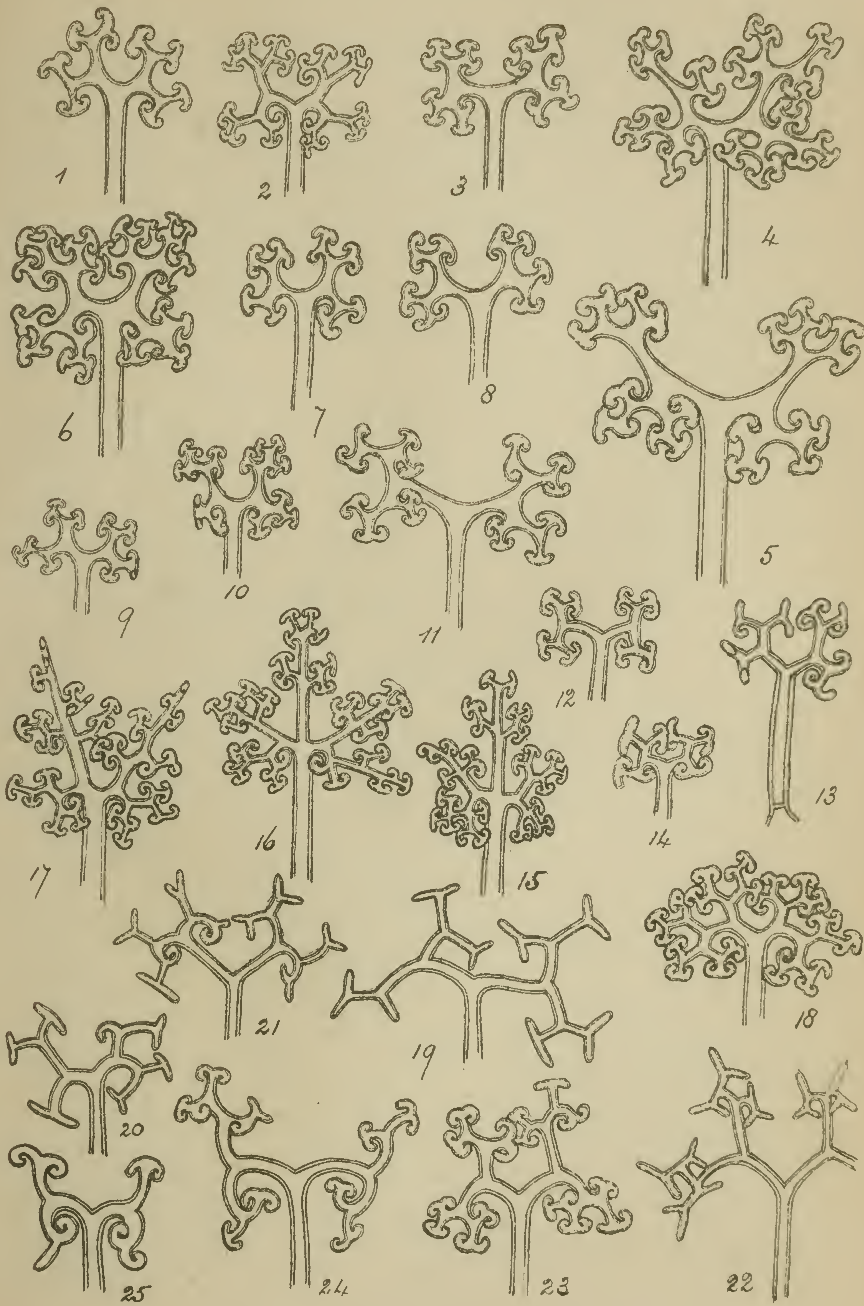

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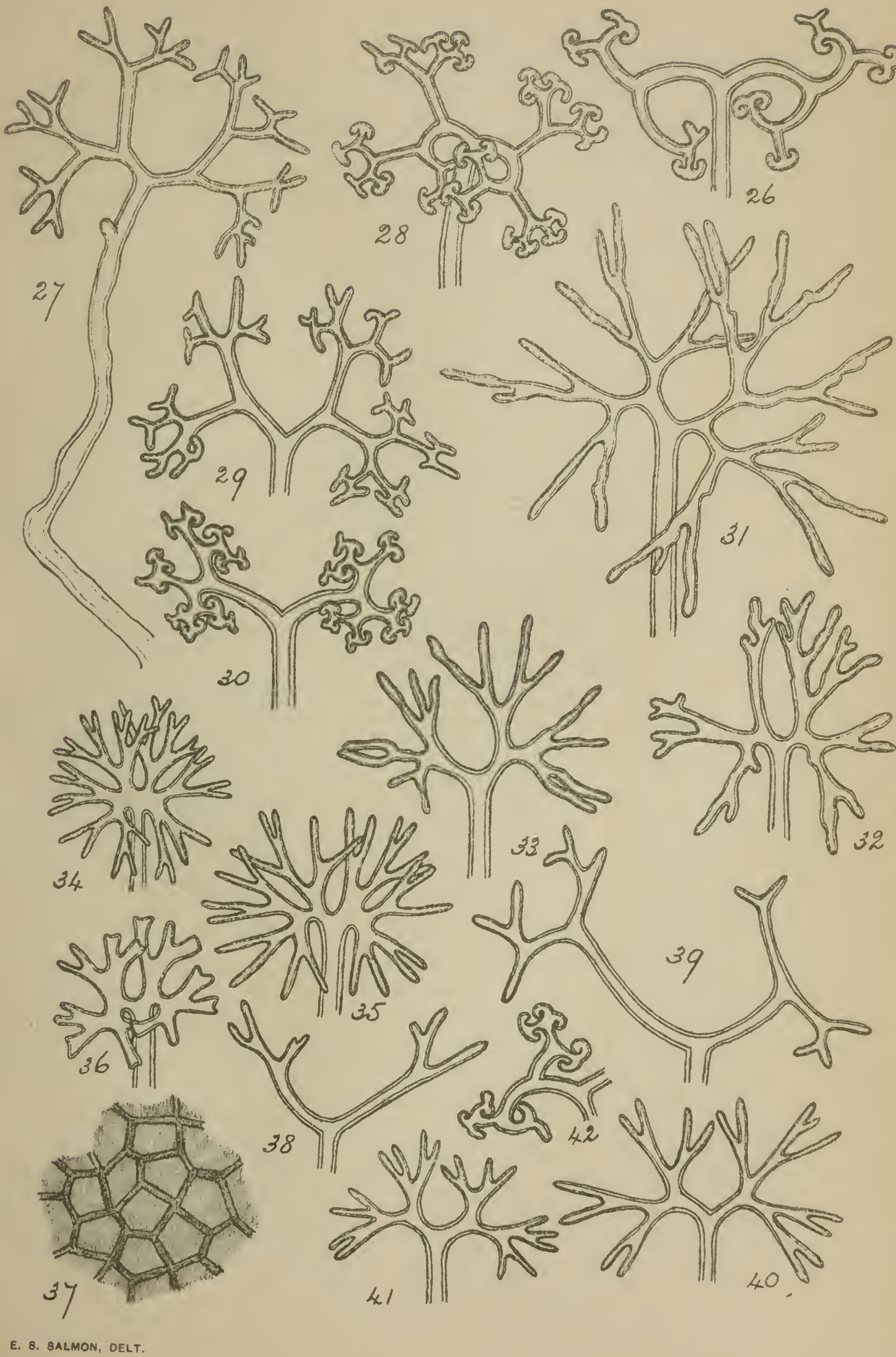

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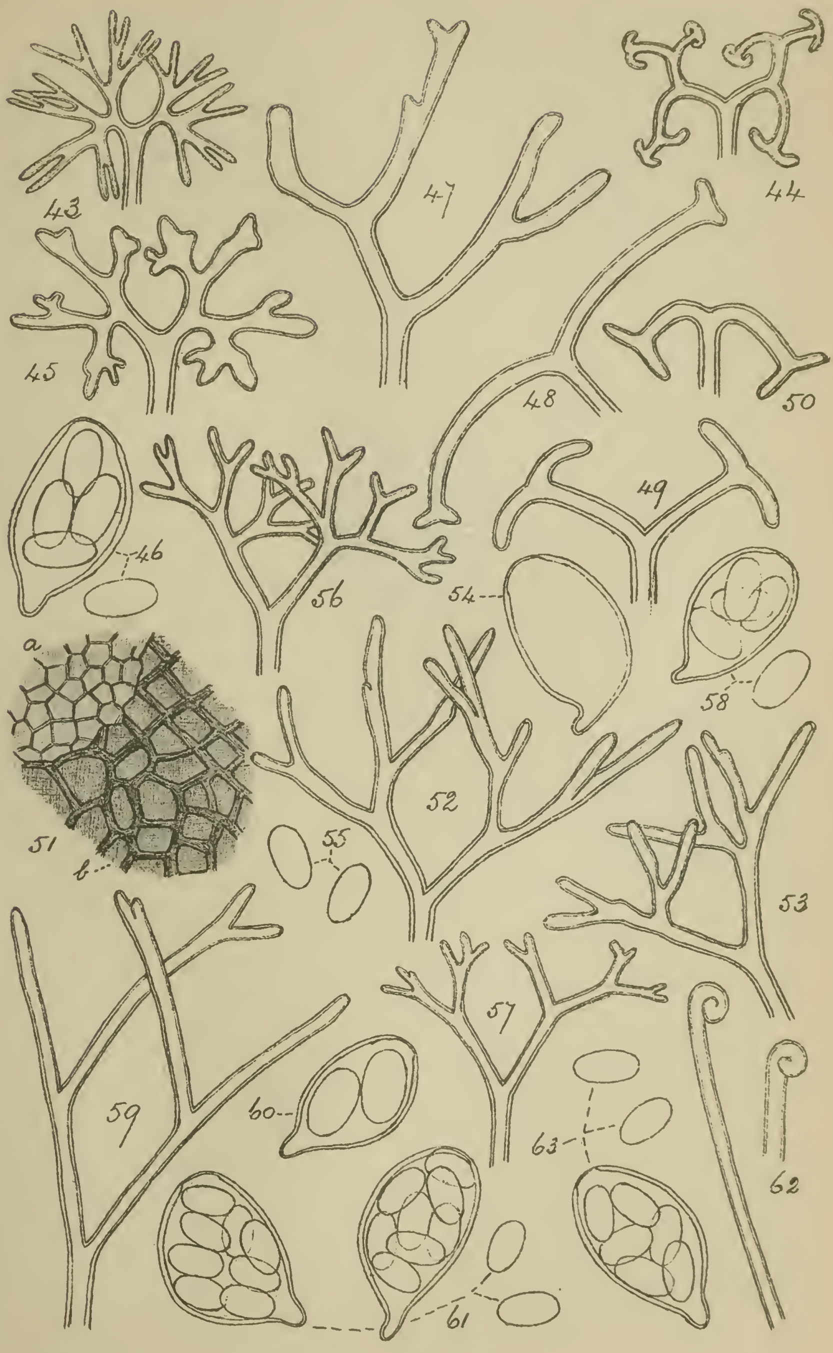

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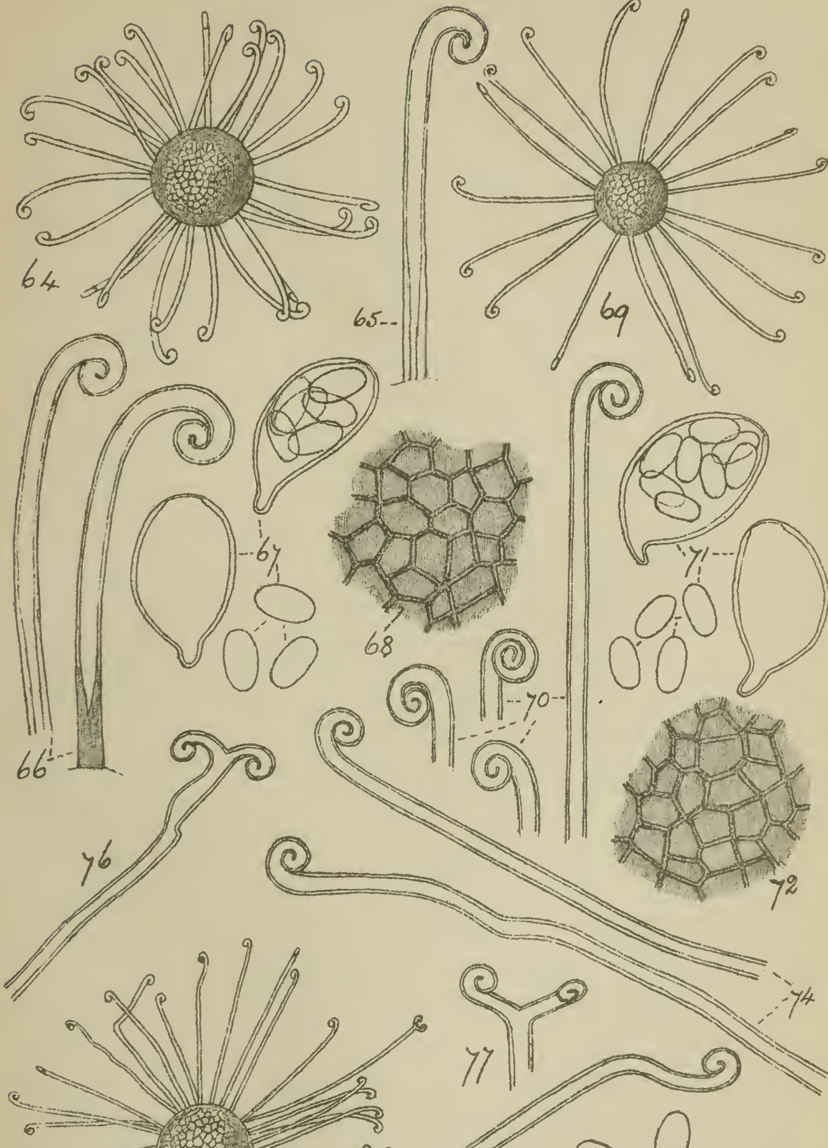

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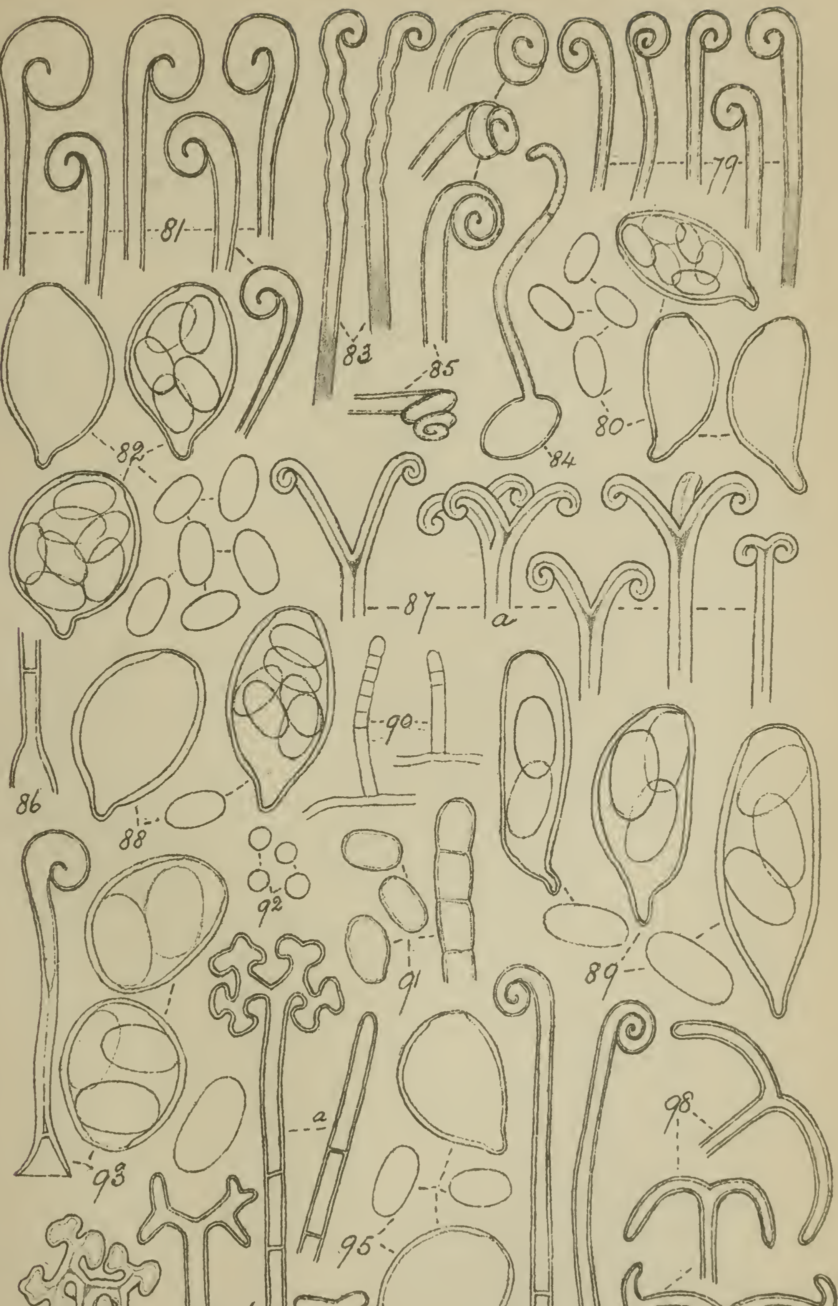

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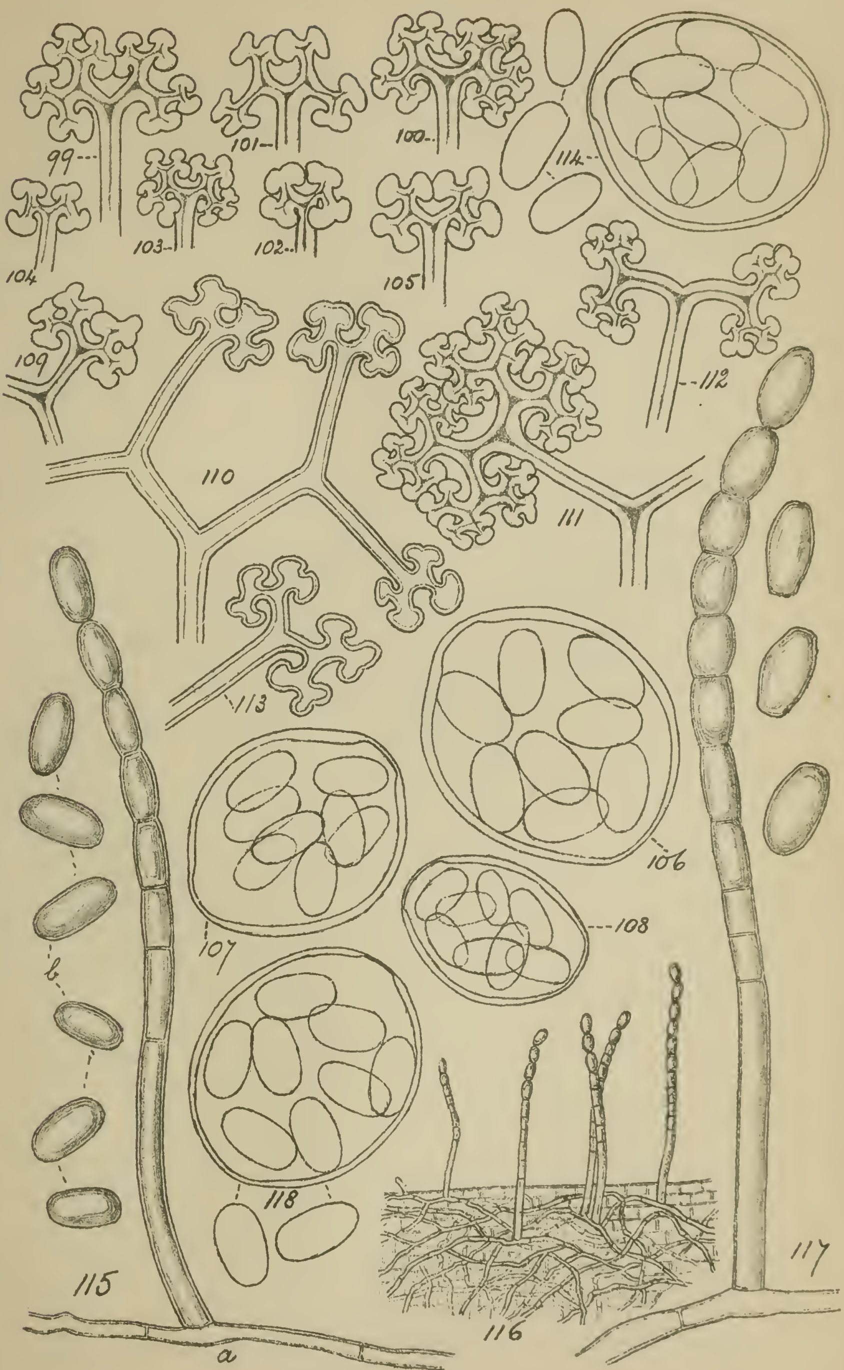

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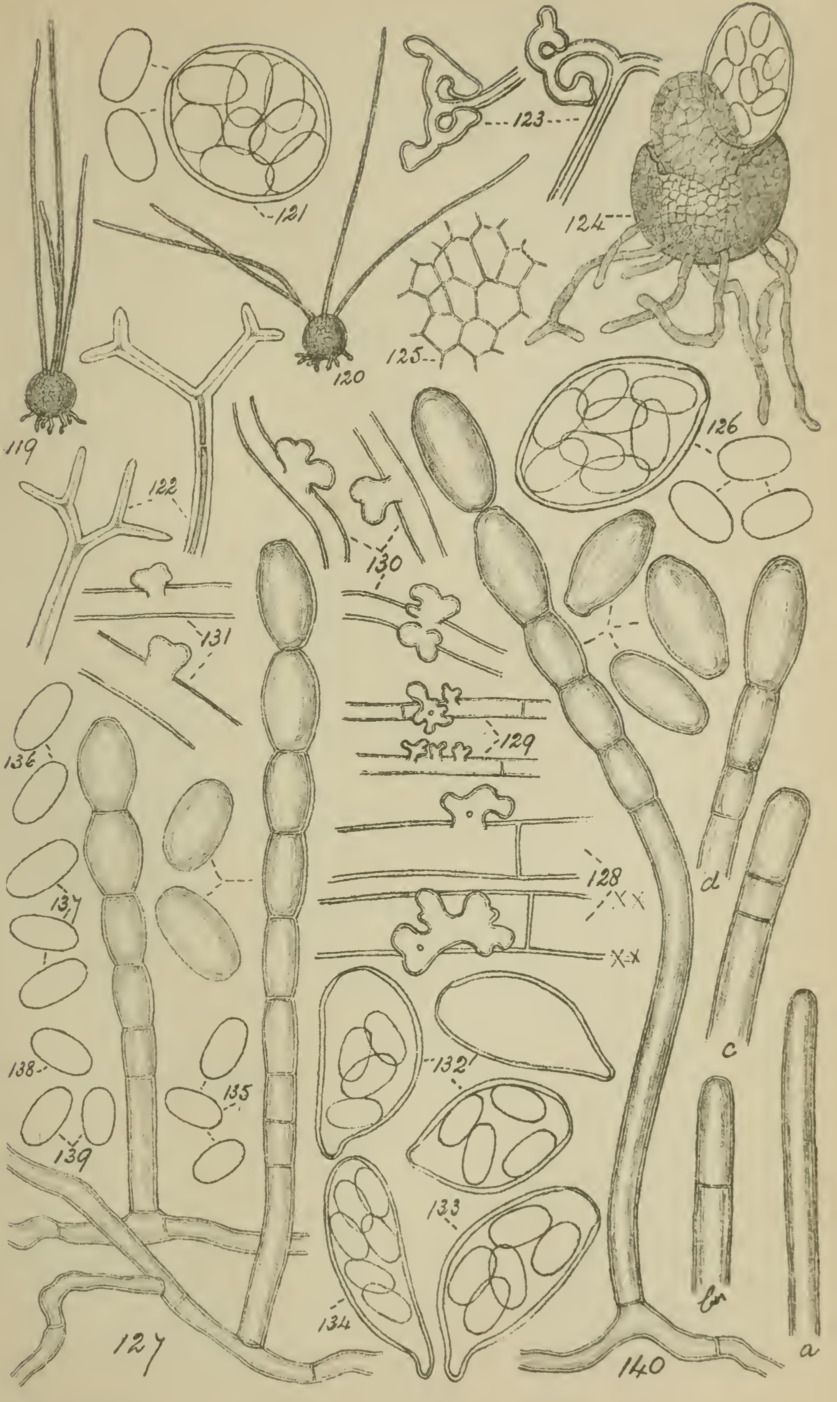

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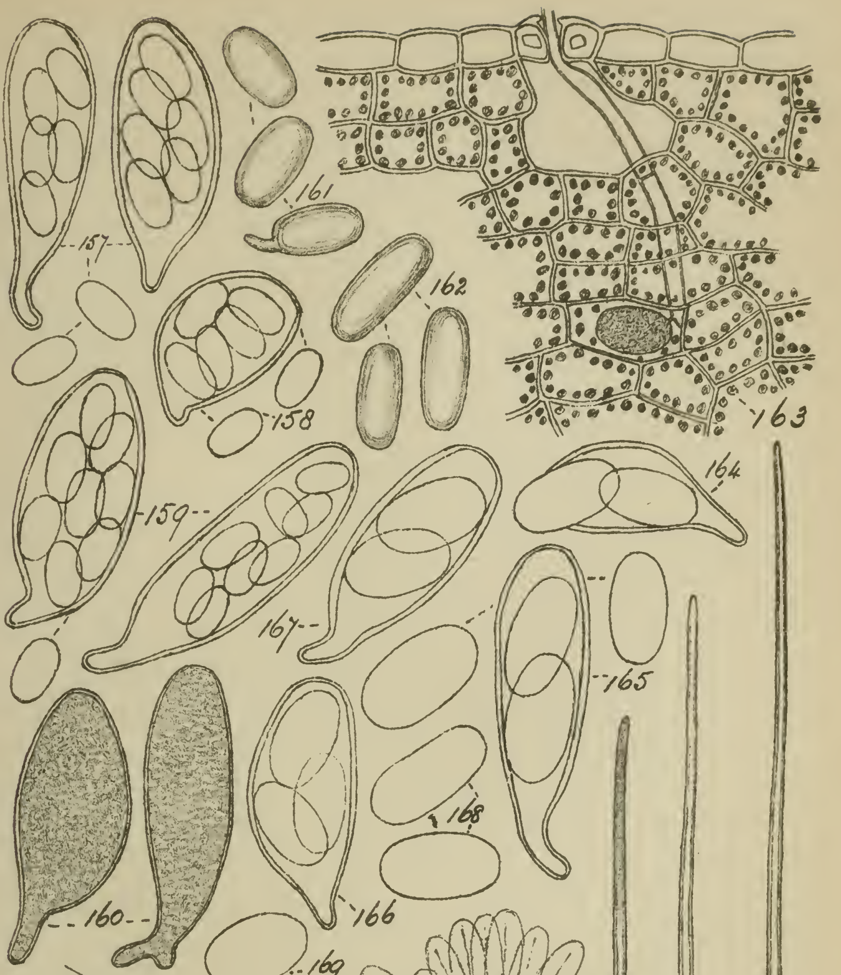

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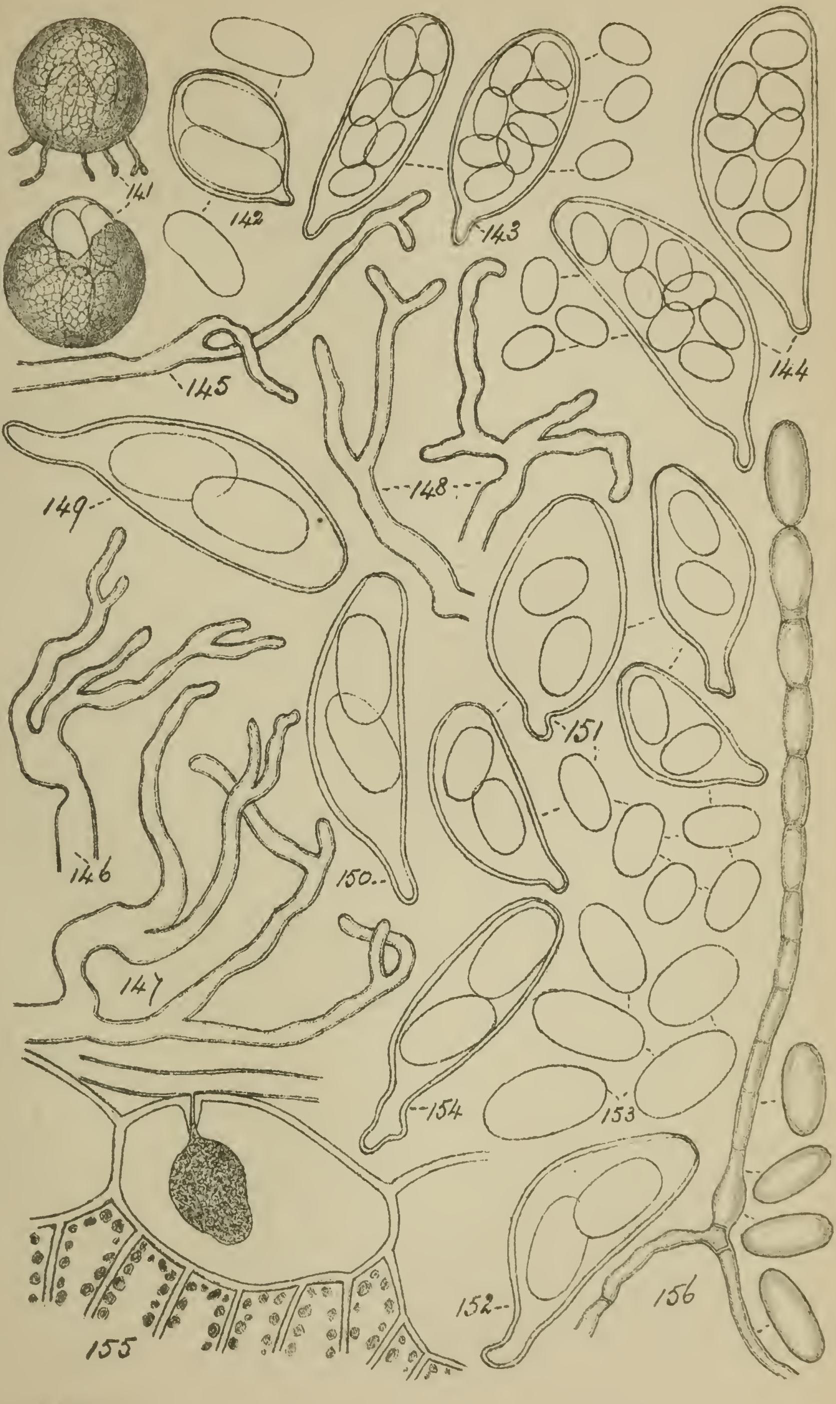

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HOST–INDEX

Records for plants prefixed by * (before the generic or specific name) have not been personally verified; the authority for these will be found indicated in the list of host-plants given under the species in question. *E.* = *Erysiphe*; *M.* = *Microsphaera*; *P. corylea* = *Phyllactinia*; *P.* = *Podosphaera*; *S.* = *Sphaerotheca*; *U.* = *Uncinula*.

Acanthophyllum glandulosm....E. taurica.
Acer campestre....U. aceris.
* " " ....P. corylea.
A. dasycarpum....U. circinata.
A. monspessulanum....U. aceris and var. Tulasnei.
*A. Pennsylvanicum....U. circinata.
A. pictum....U. aceris.
A. platanoides....U. aceris and var. Tulasnei.
* " ....P. corylea.
A. Pseudo-platanus....U. aceris and P. corylea.
* " ....U. aceris var. Tulasnei.
A. rubrum....U. circinata.
* " ....U. aceris.
A. saccharinum....U. circinata.
* " ....P. corylea.
A. spicatum....U. circinata and U. aceris.
A. Tataricum....U. aceris.
Achillea Millefolium, Ptarmica....E. cichoracearum.
*A. Ptarmica....E. polygoni.
* " ....E. taurica.
Aconitum *Anthora, Fischeri, Napellus, *paniculatum....E. polygoni.
Actaea spicata.... "
Actinidia arguta....U. necator and P. corylea.
A. Kolomikta, polygama....U. necator.
Actinomeris squarrosa....E. cichoracearum.
Adenocaulon bicolor....S. humuli var. fuliginea.
Adenostyles albida.... " "
A. *alpina, viridis....E. cichoracearum.
*Adonis vernalis....E. polygoni.
*Aegopodium Podagraria.... "
Aesculus *arguta, *flava, glabra, Hippocastanum, Pavia....U. flexuosa.
Aethusa Cynapium....E. polygoni.
Agrimonia Eupatoria....S. humuli.
Agropyron *caninum, glaucum, repens, scabrum, *tenerum..E. graminis.
Agrostis *alba, *exarata.... "
Ailanthus sp....U. Delavayi.
Ajuga ciliata....S. humuli var. fuliginea.
*A. reptans....E. polygoni.

Albizzia oplhantha ...... "
Alchemilla arvensis, vulgaris ...... S. humuli.
Alhagi *camelorum, maurorum ...... E. taurica.
Alnus glutinosa ...... M. alni and P. corylea.
" × incana ...... P. corylea.
A. incana ...... P. corylea, E. aggregata, E. polygoni (vernalis) M. alni and U. salicis var. Miyabei.
A. incana var. virescens ...... M. alni and P. corylea.
A. maritima ...... " " and U. salicis var. Miyabei.
A. rubra ...... M. alni and P. corylea.
A. serrulata ...... " " and E. aggregata.
A. viridis ...... M. alni and E. aggregata.
*Alopecurus agrestis ...... E. graminis.
Althaea ficifolia, Kurdica ...... E. taurica.
Alyssum calycinum, *campestre ...... E. polygoni.
Ambrosia artemisiæfolia, psilostachya, trifida and var. integrifolia ...... E. cichoracearum.
*Amelanchier alnifolia ...... E. polygoni.
A. Canadensis ...... P. oxyacanthae and P. corylea.
*A. maculatum ...... E. polygoni.
*Ampelopsis cuspidata ...... U. necator.
Amphicarpaea Edgeworthii var. Japonica, monoica ...... E. polygoni.
Amsinckia spectabilis ...... E. cichoracearum.
Anarthrophyllum rigidum ...... P. corylea.
*Anchusa Italica ...... E. cichoracearum.
A. officinalis ...... E. polygoni.
* " ...... E. cichoracearum.
Andromeda sp ...... M. alni var. vaccinii.
Anemone dichotoma, *ranunculoides, *thalictroides, Virginiana ...... E. polygoni.
Angelica sylvestris ...... P. corylea and E. polygoni.
Anthriscus Cerefolium, sylvestris ...... E. polygoni.
Antirrhinum Orontium ...... E. cichoracearum.
* " " ...... E. polygoni.
Apera Spica-venti ...... E. graminis.
Aphananthe aspera ...... U. polycheta and U. Clintonii.
Apios tuberosa ...... M. diffusa and M. alni.
Aplopappus sp. ...... E. cichoracearum.
*Apocynum sp ...... "
Aquilegia Canadensis, vulgaris ...... E. polygoni.

*Arabis alpina....S. "Castagnei."
*A. Turrita....E. polygoni.
Archangelica officinalis.... "
Arctium majus....E. cichoracearum and S. humili var. fuliginea.
A. minus....E. taurica and E. cichoracearum.
A. nemorosum....E. cichoracearum.
Arenaria decipiens, *juniperina....E. polygoni.
Aristotelia racemosa.... " (E. densa).
Arnica cordifolia, montana....S. humuli var. fuliginea.
*Arrhenatherum avenaceum....E. graminis.
Artemisia Absinthium, *biennis, campestris, *discolor, dracunculoides....E. cichoracearum.
A. Dracunculus....E. taurica.
A. glauca, Japonica, Ludoviciana and var. gnaphalodes, vulgaris....E. cichoracearum.
A. vulgaris....P. corylea.
* "....U. salicis.
*Asclepias Syriaca....P. corylea.
A. variegata....E. cichoracearum.
Asperugo procumbens.... "
*Asperula odorata.... "
* " "....E. polygoni.
*Aster adscendens....E. cichoracearum.
*A. Bellidiastrum....S. "Castagnei."
A. canescens, communis, commutatus....E. cichoracearum.
*A. commutatus....E. polygoni.
A. *conspicuus, cordifolius, *corymbosus, *diffusus, Drummondii, ericoides and var. *villosus, foliaceus, var. Eatoni, Fremonti, *grandiflorus, *junceus, laevis and var. laevigatus, longifolius, *macrophyllus, *multiflorus, *oblongifolius, paniculatus, prenanthoides, puniceus, sagittifolius, *salicifolius, *Shortii, Tradescanti, *umbellatus, *vimineus var. foliolosus....E. cichoracearum.
Astragalus sp....E. taurica.
A. adsurgens....E. polygoni and M. euphorbiae.
* "....M. alni.
A. alpinus....S. humuli var. fuliginea.
A. baeticus, caespitosus, Canadensis, *caryocarpus....E. polygoni.
*A. Cicer....M. astragali.
A. Cooperi....M. euphorbiae.
*A. decumbens....E. polygoni.
A. Drummondii....M. euphorbiae.
A. frigidus var. Americanus, Gebleri....E. polygoni,
A. Glycyphyllos....M. astragali.
A. *Glycyphyllos, *hypoglottis, *junceus, Lamberti....E. polygoni.
A. Mortoni....M. euphorbiae.

*A. multiflorus	E. polygoni.
*A. Onobrychis	M. astragali.
A. oroboides var. Americanus, reflexistipulus, *triphyllus, irrigatus	E. polygoni.
Avena *fatua, sativa	E. graminis.
Ballota nigra	E. galeopsidis.
* " "	E. cichoracearum.
Balsamorhiza sagittata	"
Baptisia tinctoria	E. polygoni.
Bartsia Odontites	S. humuli var. fuliginea.
Beckmannia erucaeformis	E. graminis.
*Bellis annua	E. tortilis.
Berberis Aquifolium	M. berberidis.
B. vulgaris	M. berberidis and P. corylea.
Betula alba	M. alni and P. corylea.
* " "	U. salicis.
B. lenta, lutea	M. alni.
B. *lutea, nana, nigra, occidentalis, papyracea	P. corleay.
*B. pumila	M. alni.
Bidens cernua, chrysanthemoides, connata, frondosa, tripartita	S. humuli var. fuliginea.
Bigelowia graveolens and var. albicaulis	E. polygoni var. sepulta.
B. viscidiflora	E. cichoracearum.
Boltonia asteroides	"
Borago officinalis	"
Brassica Rapa, *Sinapistrum, *sinapoides	E. polygoni.
Breynia acuminata	"
Bromus *asper, breviaristatus, *Madritensis, *mollis, rubens, *secalinus, sterilis, *tectorum, *unioloides	E. graminis.
Broussonetia papyrifera	P. corylea.
*Buxus sempervirens	"
* " "	U. salicis.
Calamintha Chinensis	S. humuli var. fuliginea.
Calendula arvensis	" "
* " "	E. polygoni.
C. officinalis	S. humuli var. fuliginea.
* "	E. cichoracearum.
* "	E. polygoni.
Caltha palustris	"
* " "	S. "Castagnei."
Calystegia Sepium	E. polygoni.
*Campanula glomerata	E. cichoracearum.
C. rapunculoides	E. polygoni.
Capparis spinosa	E. taurica.
Capsella Bursa-pastoris	E. polygoni.
Caragana arborescens	"
Cardamine sp.	E. cichoracearum.
Carduus sp.	E. polygoni.

C. acanthoides....E. cichoracearum.
*C. crispus....E. taurica.
C. *tenuiflorus, *viridis....E. cichoracearum.
*Carlina acaulis.... "
C. corymbosa, lanata....E. taurica.
*C. vulgaris....S. "Castagnei."
Carpesium abrotanoides....S. humuli var. fuliginea.
Carpinus Americana....P. corylea.
* " " ....M. alni.
C. Betulus....P. corylea.
Carthamus lanatus....E. taurica.
*Carum Persicum....E. polygoni.
*Carya sp....P. corylea.
C. alba, sulcata....M. alni.
*Cassia Chamaecrista....E. polygoni.
*Castanea dentata....M. alni.
* " " ....P. corylea.
C. sativa, and var. Americana....P. corylea and M. alni.
" var. Japonica....M. alni.
Catalpa bignonioides, speciosa....M. alni var. vaccinii and P. corylea.
C. syringaefolia....E. polygoni.
Caucalis Japonica.... "
Ceanothus Americanus....M. alni.
Celastrus articulatus....U. Sengokui.
C. scandens....P. corylea.
* " ....M. alni.
Celtis Americana....U. parvula.
C. Mississippiensis....U. polychaeta.
C. occidentalis....U. polychaeta, U. parvula, and S. phytoptophila.
* " ....U. confusa.
C. tala....U. polychaeta.
Centaurea *Jacea, nigra, nigrescens, Scabiosa....E. cichoracearum.
*C. Scabiosa....E. polygoni.
Cephalanthus occidentalis....M. alni and P. corylea.
*Cerinthe major....E. taurica.
*C. minor....E. cichoracearum.
Chaerophyllum aromaticum, aureum, *bulbosum, hirsutum, *nodosum, temulum, *Villarsii....E. polygoni.
Chelone glabra....E. galeopsidis.
* " " ....E. polygoni.
* " " ....P. corylea.
Chelonopsis moschata....E. galeopsidis.
*Chionanthus Virginica....P. corylea.
Chondrilla juncea....E. taurica.
Chrysopsis villosa....E. cichoracearum.
*Cicer Songaricum....E. taurica.

Cichorium Intybus....................E. cichoracearum.
* " " ....S. "Castagnei."
*Cicuta virosa....................E. polygoni.
*Cimicifuga foetida.................... "
Circaea Lutetiana.................... "
Clematis alpina and *var. Sibirica, Flammula, fusca var. Yezoensis, *integrifolia, *leucantha, *ligusticifolia.................... "
*C. orientalis....................E. cichoracearum.
C. recta....................E. polygoni.
C. Songarica....................E. taurica.
C. Virginiana, Vitalba....................E. polygoni.
*C. Vitalba....................P. corylea.
Cnicus altissimus, and var. discolor, *arvensis....................E. cichoracearum.
*C. arvensis....................E. taurica
C. Cardunculus.................... "
C. *Cardunculus, eriophorus, heterophyllus, lanceolatus....................E. cichoracearum.
C. lanceolatus....................E. polygoni.
* " ....E. taurica.
C. oleraceus, *rivularis, undulatus and var. canescens....................E. cichoracearum.
C. Weyrichii var. Grayanum....................S. humuli var. fuliginea.
*Coccinea dubia....................E. taurica.
*Colliguaja Brasiliensis....................P. corylea.
Collomia gracilis, heterophylla, linearis....................S. humuli.
*C. linearis....................S. humuli var. fuliginea.
Colutea arborescens....................M. euphorbiae and E. polygoni.
C. cruenta....................M. euphorbiae.
*Conium maculatum....................E. polygoni.
Convolvulus Ammannii, arvensis, sagittatus.................... "
Coreopsis aristosa, *aurea, tripteris....................S. humuli var. fuliginea.
*Cornus alba....................E. tortilis.
C. alternifolia....................M. alni.
C. Amomum....................P. corylea.
* " ....M. alni.
C. *candidissima, *circinata, florida....................P. corylea
C. macrophylla....................M. alni.
C. Mas, Nuttallii, sanguinea....................P. corylea.
C. sanguinea....................E. tortilis.
C. stolonifera....................P. corylea
* " ....M. alni.
Coronilla *Emerus, *varia....................E. polygoni.
Corylus Americana....................M. alni and P. corylea.
C. Avellana and var. laciniata, Colurna, rostrata....................P. corylea.
C. rostrata and var. Mandshurica....................M. alni.
C. tubulosa....................P. corylea.
Cotoneaster sp.................... "
Cotyledon Semenovii....................M. umbilici.
*Cousinia uncinata....................E. cichoracearum.
*Crambe Sewerzowi....................E. polygoni.

*Crataegus sp.	U. prunastri.
C. *Azarolus, coccinea	P. oxyacanthae.
C. coccinea	P. corylea.
C. Crus-galli	P. oxyacanthae.
* " occidentalis	P. corylea.
C. Oxyacantha, rivularis, *sanguinea	P. corylea and P. oxyacanthae.
C. spathulata, *subvillosa, tomentosa	P. oxyacanthae.
C. tomentosa	P. corylea.
" var. punctata	P. oxyacanthae.
" var. pyrifolia	" and P. corylea.
Crepis paludosa	S. humuli var. fuliginea.
C. *paludosa, parviflora	E. cichoracearum.
C. runcinata	S. humuli var. fuliginea.
*C. tectorum	S. "Castagnei."
Crupina vulgaris	E. cichoracearum.
*Cucumis sativus	S. "Castagnei."
* " "	E. polygoni.
*Cucurbita maxima	S. "Castagnei."
C. Pepo	E. cichoracearum.
* "	E. polygoni.
* "	E. "Castagnei."
Cuphea viscosissima	E. polygoni.
Cynara Cardunculus	E. taurica.
Cynoglossum Morisoni, officinale	E. cichoracearum.
*Cytisus purpureus	E. polygoni.
Dactylis glomerata	E. graminis.
*Dahlia	E. cichoracearum.
* "	E. polygoni.
Daphne alpina	"
Daucus grandiflorus	"
D. maximus	E. taurica.
Delphinium Ajacis, *azureum, consolida, elatum, formosum, *grandiflorum, orientale, *Tiroliense, vestitum	E. polygoni.
*Deschampsia caespitosa	E. graminis.
Desmanthus brachylobus	E. polygoni.
Desmodium Canadense	M. diffusa.
* " "	P. corylea.
D. *canescens, *cuspidatum, paniculatum, sessilifolium	M. diffusa.
*Diarthron vesiculosum	E. taurica.
Diervilla Japonica	E. polygoni.
Dimorphotheca pluvialis	S. humuli var. fuliginea.
*Diospyros Virginiana	P. oxyacanthae.
*Diplotaxis tenuifolia	E. polygoni.
*Dipsacus Fullonum	S. "Castagnei."
D. laciniatus	S. humuli and E. polygoni.
D. sylvestris	S. humuli.

* "	E. polygoni.
Doronicum Austriacum, *grandiflorum	S. humuli var. fuliginea.
*Dorycnium herbaceum	E. taurica.
Draba alpina var. glacialis, hirta	S. humuli var. fuliginea.
*D. hirta	E. polygoni.
D. incana	S. humuli var. fuliginea.
Dysodia *chrysanthemoides, *papposa	E. cichoracearum.
Echinospermum *Lappula, *Redowskii, Virginicum	"
*Echium Italicum	"
E. vulgare	E. polygoni.
* "	E. cichoracearum.
Elaeoselinum Lagascae	E. taurica.
Ellisia Nyctelea	E. cichoracearum.
*Elsholtzia sp	P. corylea.
E. cristata	E. polygoni.
*Elymus condensatus	E. graminis.
Epigaea repens	M. alni var. vaccinii
Epilobium adenocaulon, alpinum	S. humuli.
*E. angustifolium	S. "Castagnei."
* "	U. salicis.
E. cephalostigma, coloratum, hirsutum, jucundum, montanum, palustre, parviflorum, parviflorum × roseum, pubescens, roseum	S. humuli.
*E. tetragonum	S. "Castagnei."
* "	E. cichoracearum.
Erechtites praealta	S. humuli var. fuliginea.
* " "	E. polygoni.
Erigeron acris, annuus	S. humuli var. fuliginea.
*E. armerifolius	E. cichoracearum.
E. Canadensis	S. humuli var. fuliginea.
E. *corymbosus, *divaricatus, elatus, *glabellus, macranthus, *strigosus	E. cichoracearum.
Eriogonum nudum	E. cichoracearum.
Erodium moschatum	S. humuli.
Eryngium campestre	E. taurica.
E. macrocalyx	E. polygoni.
*E. Noëanum	E. taurica.
Erysimum *cheiranthoides, *odoratum	E. polygoni.
Erythrina sp	P. corylea.
Eugenia sp	U. australis.
Euonymus atropurpureus	M. alni.
E. Europaeus	M. euonymi.
* "	P. corylea.
*E. verrucosus	M. euonymi.
Eupatorium ageratoides	E. ? galeopsidis.
E. cannabinum	E. cichoracearum.
* "	S. "Castagnei."
E. perfoliatum, purpureum	E. cichoracearum.
Euphorbia corollata	M. euphorbiae.

E. dulcis, helioscopia.......S. mors-uvae.
E. hypericifolia.......M. euphorbiae.
E. lanata.......E. taurica.
*E. marginata.......M. euphorbiae.
E. palustris, Peplus, platyphyllos.......S. mors-uvae.
E. Preslii.......M. euphorbiae.
E. stricta, *virgata.......S. mors-uvae.
Euphrasia officinalis.......S. humuli var. fuliginea.
*Exochorda Alberti.......E. taurica.
Fagopyrum esculentum.......E. polygoni.
Fagus *atropunicea, ferruginea.......M. alni.
*F. ferruginea.......P. corylea.
F. sylvatica....... "
Falcaria vulgaris.......E. polygoni.
*Falcata comosa....... "
Fatoua pilosa, var. subcordata.......S. humuli var. fuliginea.
Festuca *arundinacea, elatior, *gigantea, *heterophylla.......E. graminis.
Foeniculum vulgare.......E. taurica.
Forestiera acuminata.......M. alni.
Fragaria sp.......P. corylea.
F. glauca.......S. humuli.
* ".......S. humuli var. fuliginea.
Fraxinus Americana, excelsior and var. diversifolia.......P. corylea.
F. longicuspis.......U. fraxini.
F. Mandshurica, Ornus, *oxyphylla, pubescens, quadrangulata, sambucifolia, viridis.......P. corylea.
Gaillardia aristata.......S. humuli var. fuliginea.
* " ".......E. cichoracearum.
Galeopsis Tetrahit, versicolor.......E. galeopsidis.
Galium Aparine.......E. cichoracearum.
* " ".......E. polygoni.
G. boreale.......E. cichoracearum.
* ".......E. polygoni.
G. *Mollugo, *sylvaticum.......E. polygoni.
G. triflorum.......E. cichoracearum.
Gaylussacia resinosa.......M. alni var. vaccinii.
Geranium caespitosum, Carolinianum.......S. humuli.
*G. dissectum.......S. "Castagnei."
* ".......E. polygoni.
G. ibericum, incisum, maculatum.......S. humuli.
G. maculatum, *molle.......E. polygoni.
*G. molle.......S. "Castagnei."
G. nepalense, palustre, *pratense.......S. humuli.
G. *pratense, *pusillum *Pyrenaicum.......E. polygoni.
G. Richardsonii.......S. humuli.
* ".......E. polygoni.
G. sylvaticum.......S. humuli.
* " *tuberosum.......E. polygoni.
Gerardia grandiflora, quercifolia.......S. humuli var. fuliginea.

Geum album, Kokanicum, *macrophyllum, strictum............S. humuli.
G. urbanum ....E. polygoni.
* " ....E. cichoracearum.
G. Virginianum ....S. humuli.
Gilia aristella, heterophylla, linearis................................ "
Gleditschia triacanthos ....M. alni.
Glyceria *aquatica, *nervata..E. graminis.
Glycyrrhiza lepidota ....M. diffusa.
Gnaphalium sylvaticum..E. cichoracearum.
Grindelia squarrosa .... "
Gundelia Tournefortii ....E. taurica.
Gutierrezia Euthamiae..E. cichoracearum.
* " " ....E. polygoni.
Gymnocladus sp ....M. alni.
Gypsophila Gmelini...E. polygoni
Haloxylon Ammodendron..E. taurica.
Hamamelis Japonica ....P. corylea.
H. Virginiana..P. biuncinata.
* " ....P. corylea.
*Haplophyllum Sieversianum...E. taurica.
Hedysarum Falconeri..E. taurica.
Helenium autumnale...E. cichoracearum.
*Helianthella Parryi... "
Helianthemum Oelandicum...E. taurica.
H. vulgare...S. humuli var. fuliginea.
Helianthus annuus, *Californicus, and var. *Utahensis, doronicoides, giganteus, *grosseserratus, Maximiliani, orgyalis, petiolaris, rigidus, strumosus, tuberosus, and var. subcanescens ....E. cichoracearum.
Helichrysum arenarium.. "
Heracleum asperum, *flavescens, palmatum, Sibiricum, Sphondylium..E. polygoni.
Hesperis matronalis, *tristis.. "
*Heuchera Americana.. "
*H. parvifolia...P. corylea.
* " ....S. " Castagnei."
Hieracium sp...S. humuli var. fuliginea.
H. albiflorum, *boreale, *Canadense, *incisum, lycopsifolium, *murorum, prenanthoides...................................E. cichoracearum.
*H. sabaudum...S. " Castagnei."
* " *vulgatum...E. cichoracearum.
Hippophaë rhamnoides...P. corylea.
*Holcus mollis...E. graminis.
Hordeum *jubatum, *murinum, secalinum, vulgare.......................... "
Hosackia parviflora..E. polygoni.
Humulus Japonicus, Lupulus...S. humuli.
*H. Lupulus..E. cichoracearum.
* " ....P. corylea.
Hydrophyllum appendiculatum..

H. Canadense, capitatum, *macrophyllum, *occidentale, Virginicum	E. cichoracearum.
H. Virginicum	S. humuli var. fuliginea.
Hyoscyamus albus, niger	E. cichoracearum.
*H. niger	E. polygoni.
Hypericum atomarium, hirsutum	"
*H. humifusum	E. cichoracearum.
H. montanum, perforatum, quadrangulum	E. polygoni.
Ilex decidua	P. corylea and M. alni.
I. *mollis, *verticillata	M. alni.
Impatiens balsamina	S. "Castagnei."
I. noli-tangere, textori	S. humuli var. fuliginea.
*Inula Britannica	E. cichoracearum.
I. dysenterica	S. humuli var. fuliginea.
I. *Helenium, hirta	E. cichoracearum.
I. nervosa	E. taurica.
I. Oculus-Christi, salicina	E. cichoracearum.
*I. salicina	E. polygoni.
*Isatis tinctoria	"
Iva *frutescens, *xanthifolia	E. cichoracearum.
Johrenia sp	E. polygoni.
*Juglans sp	P. corylea.
J. cinerea, nigra	M. alni.
Kuhnia eupatorioides	E. cichoracearum.
Laburnum vulgare	M. guarinonii.
Lactuca brevirostris, *Floridana	S. humuli var. fuliginea.
*L. muralis	E. cichoracearum.
* "	E. polygoni.
*L. pulchella	E. cichoracearum.
L. Raddiana	S. humuli var. fuliginea.
L. Scariola	E. cichoracearum.
L. Sibirica	S. humuli var. fuliginea.
*L. viminea	E. cichoracearum.
Lagerstroemia Indica, ovalifolia	U. Australiana.
Lamium album, *amplexicaule, galeobdolon, *intermedium, maculatum, purpureum	E. galeopsidis.
Laportea bulbifera	E. cichoracearum.
*Lapsana communis	E. cichoracearum.
* " "	S. "Castagnei."
Lathyrus Aphaca, *montanus, *Nissolia	E. polygoni.
L. ochroleucus	M. alni.
* "	M. diffusa.
*L. palustris	M. alni.
L. pisiformis, *polymorphus, polyphyllus, pratensis	E. polygoni.
L. pratensis	M. alni.
L. tuberosus, uliginosus, venosus	E. polygoni.
L. venosus	M. alni.
Leontodon autumnalis	S. humuli var. fuliginea.
Leonurus Cardiaca	E. galeopsidis.

Lespedeza capitata, hirta, striata......M. diffusa.
*L. striata......E. polygoni.
L. violacea......M. diffusa.
Ligustrum medium......M. alni.
*Linaria genistifolia......E. polygoni.
*L. vulgaris......S. "Castagnei."
Liriodendron Tulipifera......P. corylea and
E. polygoni.
Lithospermum arvense......E. cichoracearum.
* " " ......E. polygoni.
L. officinale......E. cichoracearum.
*Lolium perenne......E. graminis.
Lonicera alpigena......M. alni var lonicerae.
L. caerulea......M. alni var. divaricata.
L. Caprifolium......M. alni var. lonicerae.
" ......P. corylea.
L. flava......M. alni and var. lonicerae.
L. glauca, glaucescens, *hirsuta......M. alni.
L. *hispida, implexa......M. alni var. lonicerae.
L. involucrata......M. alni.
L. lutea, nigra......M. alni var. lonicerae.
L. oblongifolia, parviflora......M. alni.
L. Periclymenum......M. alni var. lonicerae.
L. sempervirens, *Sullivantii......M. alni.
L. tatarica, Xylosteum ......M. alni var. lonicerae.
L. Xylosteum......P. corylea.
Lophanthus anisatus ......S. humuli var. fuliginea.
Lotus *corniculatus, *major, Purshiana......E. polygoni.
*Lunaria rediviva ...... "
Lupinus albus, *angustifolius, *argenteus, var. argophyllus,
laxiflorus, luteus, parviflorus, perennis, sericeus...... "
Lychnis *alba, dioica, *sylvestris ...... "
Lycium barbarum, Europaeum, *ovatum ......M. Mougeotii.
*L. ovatum......L. "Castagnei."
*L. Ruthenicum ......M. Mougeotii.
Lycodesmia juncea......E. cichoracearum.
*Lycopersicum esculentum......E. polygoni.
Lycopsis arvensis...... "
* " " ......E. cichoracearum.
Lycopus Europaeus ...... "
*Lyonia paniculata ......M. alni and var. vaccinii.
Lygodesmia juncea ......E. cichoracearum.
Lythrum Salicaria......E. polygoni.
Madia glomerata ......E. cichoracearum.
Magnolia *acuminata, *Fraseri, Kobus ......P. corylea.
*Malcomia maritima ......E. polygoni.
Marrubium vulgare ......E. galeopsidis.
Medicago falcata, lupulina, sativa ......E. polygoni.
Melampyrum nemorosum, pratense, sylvaticum......S. humuli var. fuliginea.

Melilotus alba, officinalis......E. polygoni.
Menispermum Canadense......M. alni.
Mentha aquatica, arvensis......E. cichoracearum.
Mercurialis perennis......P. corylea.
Mertensia maritima, Sibirica......E. cichoracearum.
Microseris aphantocarpha......S. humuli var. fuliginea.
*Mikania scandens......E. cichoracearum.
*Milium effusum......E. graminis.
*Mimulus luteus......E. cichoracearum.
Morina Persica......S. humuli.
Morus alba......P. corylea.
M. rubra......U. geniculata.
Myosotis *intermedia, *sparsiflora, *sylvatica......E. cichoracearum.
Myrrhis odorata......E. polygoni.
Napaea dioica......E. cichoracearum.
*Negundo aceroides......P. corylea.
Neillia opulifolia......S. humuli.
Nemopanthus fascicularis......M. alni.
Nepeta podostachys......E. taurica.
Nicotiana Tabacum......E. cichoracearum.
Nyssa sp......P. corylea.
Odontospermum aquaticum......E. taurica.
OEnothera albicaulis, biennis, *sinuata......E. polygoni.
*Olea Europaea......P. corylea.
*Onobrychis viciaefolia......E. polygoni.
Ononis arvensis, *hircina, repens, spinosa...... "
*Onopordon Acanthium......E. cichoracearum.
*Onosma simplicissimum...... "
Orobus lathyroides......E. polygoni.
Ostrya Virginica......U. macrospora, M. alni and P. corylea.
Oxalis corniculata, var. stricta, Suksdorfii, *violacea......M. Russellii.
Oxytropis Lamberti......E. polygoni.
Paeonia obovata, officinalis, peregrina...... "
Paliurus aculeatus......P. corylea.
*Panicum sanguinale......E. graminis.
Parietaria *debilis, *officinalis, Pennsylvanica......E. cichoracearum.
Parmentiera alata......P. corylea.
Parnassia Caroliniana......E. polygoni.
Paulownia imperialis......P. corylea.
Pedicularis cheilanthifolia......S. humuli var. fuliginea.
*P. foliosa......S. "Castagnei."
P. Groenlandica, lanceolata, pycnantha, resupinata......S. humuli var. fuliginea.
*P. resupinata......E. polygoni.
Peganum Hamala......E. taurica.
*Pentstemon barbatus......S. "Castagnei."
Peucedanum *Alsaticum, *Cervaria, Oreoselinum, sativum, terebinthaceum......E. polygoni.
Phacelia circinata, Menziesii......E. cichoracearum.

*Phaseolus helvolus........E. polygoni.
P. perennis........M. diffusa.
* " ....E. polygoni.
Philadelphus Lewisii........P. corylea.
*Phillyrea media........U. aceris.
*Phleum pratense........E. graminis.
Phloiodocarpus Dahuricus........E. polygoni.
Phlomis Herba-venti........E. taurica.
* " " ....E. galeopsidis.
P. tuberosa........E. cichoracearum.
* " ....E. taurica.
Phlox divaricata........E. cichoracearum.
* " " ....S. humuli var. fuliginea.
*P. Drummondii........E. cichoracearum.
P. longifolia........S. humuli.
P. paniculata........E. cichoracearum.
Physalis Alkekengi........S. humuli var. fuliginea.
Physospermum commutatum........E. polygoni.
Picrasma quassioides........M. alni.
Picris hieracioides........E. taurica.
* " " ....E. polygoni.
*Pilea pumila........E. cichoracearum.
P. stipulosa........E. polygoni.
Pimpinella magna, Saxifraga........ "
Pisum sativum........ "
Plantago Bellardi, *Coronopus, Kamtschatica, Lagopus, lanceolata ....E. cichoracearum.
P. lanceolata ....S. humuli var. fuliginea.
P. major, and var. Asiatica........E. cichoracearum.
* " ....S. "Castagnei."
P. maritima, media........E. cichoracearum.
P. media........S. humuli var. fuliginea.
*P. Psyllium........E. cichoracearum.
Platanus occidentalis........M. alni.
* " " ....S. "Castagnei."
Poa annua, Buckleyana, bulbosa, nemoralis, pratensis, serotina, *Sinaica, tenuifolia, trivialis ....E. graminis.
Polygonum aviculare, dumetorum, lapathifolium, *Persicaria, ramosissimum and var. *prolificum ....E. polygoni.
Populus alba, *angustifolia, balsamifera and var. candicans, ciliata, grandidentata, heterophylla, monilifera, nigra, pyramidalis, tremula, tremuloides, trichocarpa........U. salicis.
*Potentilla sp........E. polygoni.
P. Anserina........S. humuli.
*P. approximata ....S. "Castagnei."
P. bifurca........S. humuli.
* " ....E. cichoracearum.
P. Comarum, fragarioides, glandulosa, palustris........S. humuli.
*P. Pennsylvanica........S. "Castagnei."

P. reptans, Tormentilla........S. humuli.
*P. viscosa........E. cichoracearum.
Poterium Canadense and var. medium, officinale, and var. carneum........S. humuli.
*P. Sanguisorba........S. "Castagnei."
P. Sitchense (cult.), tenuifolium and var. album........S. humuli.
*Prenanthes alba........S. humuli var. fuliginea.
* " " ....E. cichoracearum.
P. *altissima, purpurea........S. humuli var. fuliginea.
P. purpurea........E. cichoracearum.
* " ....E. polygoni.
Prunella vulgaris........S. humuli var. fuliginea.
* " " ....E. cichoracearum.
Prunus Americana........P. oxyacanthae.
* " " ....P. corylea.
P. Armeniaca........P. oxyacanthae var. tridactyla.
P. Avium........P. oxyacanthae.
* " ....P. corylea.
P. Besseyi........P. oxyacanthae.
P. Cerasus........P. corylea and P. oxyacanthae.
*P. Chicasa........P. oxyacanthae.
P. communis........P. oxyacanthae var. tridactyla.
P. demissa, domestica........P. oxyacanthae.
P. domestica, insititia........P. oxyacanthae var. tridactyla.
P. insititia........U. prunastri.
*P. Mahaleb........P. "Kunzei."
P. Padus........P. oxyacanthae var. tridactyla.
*P. Pennsylvanica........P. oxyacanthae.
P. Persica........S. pannosa.
* " ....P. oxyacanthae.
P. pumila........U. prunastri and P. oxyacanthae.
P. serotina........P. oxyacanthae.
P. spinosa........P. oxyacanthae var. tridactyla and U. prunastri.
P. Virginiana........P. oxyacanthae.
Psoralea drupacea........E. taurica.
*P. tenuiflora........E. polygoni.
Pulmonaria mollis, officinalis........E. cichoracearum.
Pyrus amygdaliformis........P. corylea.
P. Aria........S. humuli.
P. Aucuparia........P. oxyacanthae.
* " ....P. oxyacanthae var. tridactyla.

P. communis	P. corylea.
P. *coronaria, Cydonia, Germanica	P. oxyacanthae.
P. Germanica	P. corylea.
P. Malus	P. leucotricha and P. oxyacanthae.
P. Sieboldi	P. leucotricha.
*P. torminalis	P. corylea.
Quercus agrifolia	S. lanestris and E. trina.
Q. alba	M. alni and var. extensa-
* "	S. lanestris.
Q. aquatica	M. alni and var. calocla. dophora and P. corylea.
Q. bicolor, and × macrocarpa, and × Michauxii, Catesbaei	M. alni.
Q. Catesbaei, *coccifera	P. corylea.
Q. coccinea and var. tinctoria	M. alni and P. corylea.
Q. crispula, dentata	M. alni.
Q. discolor	P. corylea and M. alni var. extensa.
Q. falcata	M. alni and P. corylea.
Q. glauca	E. polygoni.
Q. Ilex	P. corylea.
*Q. ilicifolia	M. alni or var. extensa.
Q. imbricaria	M. alni.
Q. Kelloggii	P. corylea.
Q. laurifolia	M. alni var. calocladophora.
Q. lyrata, macrocarpa	M. alni.
Q. macrocarpa	S. lanestris and P. corylea.
*Q. minor	S. lanestris.
Q. nigra	M. alni and vars. extensa and calocladophora and P. corylea.
Q. obtusiloba	M. alni.
Q. palustris	M. alni var. extensa and P. corylea.
Q. Phellos	M. alni.
* "	P. corylea.
Q. Prinus	M. alni and S. lanestris.
Q. Robur	P. corylea and M. alni.
Q. rubra	M. alni and var. extensa and P. corylea.
* "	S. lanestris.
Ranunculus abortivus, *aconitifolius, acris, arvensis, *Asiaticus, bulbosus, Cymbalaria, Flammula,* lanuginosus, *Lingua, *macranthus, montanus, multifidus, Pennsylvanicus, repens, sardous, *sceleratus, *septentrionalis, trachycarpus	E. polygoni.
Rhamnus alpina	P. corylea.

R. cathartica ....M. alni.
* " ....M. alni var. divaricata.
R. Frangula..M. alni var. divaricata.
Rhinanthus *angustifolius, *minor ....S. "Castagnei."
Rhododendron sp..P. corylea.
R. nudiflorum..M. alni.
Rhus copallina, glabra, *typhina..................................S. humuli.
Ribes *cereum, Cynosbati..................................S. mors-uvae.
R. Cynosbati ....P. corylea.
R. divaricatum var. irriguum, Floridanum.........................S. mors-uvae.
R. floridum..S. humuli.
* " ....M. grossulariae.
R. *gracile, Grossularia ....S. mors-uvae.
R. Grossularia ....M. grossulariae and P. corylea.
R. Hudsonianum, lacustre..................................S. mors-uvae.
R. *Magellanicum..P. corylea.
R. Missouriense..S. mors-uvae.
*R. nigrum..M. grossulariae.
R. prostratum, rotundifolium..................................S. mors-uvae.
*R. rotundifolium ....M. grossulariae.
R. rubrum..S. mors-uvae.
R. sanguineum..M. grossulariae.
Robinia *Pseudacacia, viscosa..................................E. polygoni.
*Rosa alba ....S. pannosa.
R. Arkansana..S. humuli.
R. arvensis..S. pannosa.
R. blanda ....S. humuli.
R. canina, centifolia, *cinnamomea, damascena, *dumetorum, *Eglanteria, Gallica, *glauca..................................S. pannosa.
R. lucida ....S. humuli.
R. pomifera, *rubiginosa, tomentosa, villosa..........................S. pannosa.
R. Woodsii..S. humuli.
Rubus Canadensis.. "
*R. "fruticosus" ....P. corylea.
R. hispidus, odoratus, spectabilis, *strigosus, triflorus.........S. humuli.
Rudbeckia hirta, *occidentalis..................................E. cichoracearum.
Rumex Acetosella..E. polygoni.
* " " ....E. cichoracearum.
*R. Hydrolapathum..E. polygoni.
*Saccharum officinarum..E. graminis.
Salix sp..P. corylea.
S. alba..U. salicis.
* " ....P. Schlechtendalii.
S. *angustifolia, aurita, Caprea and var. pendula...............U. salicis.
*S. Caprea..P. corylea.
S. cinerea, cordata, daphnoides, discolor, flavescens and var. Scouleriana, *fragilis, *glauca, humilis, *incana, livida, *longifolia, nigra and var. falcata, nigricans, petiolaris,

purpurea, *pyrolaefolia, repens, sericea, Seringiana,
triandra, Urbaniana, viminalis .... U. salicis.
S. viminalis .... P. Schlechtendalii.
*Salsola canescens .... E. taurica.
*Salvia glutinosa .... E. cichoracearum.
*S. verticillata .... E. galeopsidis.
Sambucus Canadensis .... M. grossulariae.
* " " .... M. alni.
*S. nigra .... P. corylea.
S. racemosa and var. pubescens .... M. grossulariae.
Sanvitalia procumbens .... S. humuli var. fuliginea.
*Saussurea sp .... E. taurica.
S. salicifolia .... E. cichoracearum.
Saxifraga cortusaefolia .... E. polygoni.
*S. punctata .... S. "Castagnei."
S. rotundifolia .... S. humuli var. fuliginea.
Scabiosa arvensis .... " "
" " .... E. polygoni.
S. Caucasica .... S. humuli.
*S. integrifolia .... S. "Castagnei."
S. *stellata, *succisa, sylvatica .... E. polygoni.
Scandix Pecten-Veneris .... "
Schizandra Chinensis .... M. alni.
*Scorzonera sp .... S. "Castagnei."
S. *hirsuta, Hispanica, humilis .... E. cichoracearum.
*S. radians .... S. "Castagnei."
Scrophularia canina .... S. humuli var. fuliginea.
Scutellaria lateriflora .... E. cichoracearum, U. Columbiana.
* " " .... E. galeopsidis.
* " " .... E. polygoni.
S. multicaulis .... E. taurica.
*S. parvula .... E. galeopsidis.
S. scordiifolia .... E. polygoni.
*Secale cereale .... E. graminis.
Selinum carvifolium .... E. polygoni.
Senecio Cacaliastrum, cordatus, Fuchsii .... S. humuli var. fuliginea.
S. hydrophilus .... E. cichoracearum.
*S. Jacobaea .... S. "Castagnei."
S. lugens .... S. humuli var. fuliginea.
*S. lyratifolius .... S. "Castagnei."
S. nemorensis. sarracenicus .... S. humuli var. fuliginea.
*S. spathulaefolius .... S. "Castagnei."
S. subalpinus .... S. humuli var. fuliginea.
S. sylvaticus .... E. cichoracearum
* " .... S. "Castagnei."
S. triangularis .... S. humuli var. fuliginea.
S. vulgaris .... E. cichoracearum.
* " .... S. "Castagnei."

*Sesbania sp........E. cichoracearum.
*Seseli Libanotis........E. polygoni.
*Sesleria caerulea........E. graminis.
Shepherdia argentea, Canadensis........S. humuli.
Siegesbeckia orientalis........S. humuli var. fuliginea.
*Silaus flavescens........E. polygoni.
*Silene noctiflora........ "
*Siler trilobum........ "
Silphium terebinthinaceum........E. cichoracearum.
Sisymbrium *Alliaria, *officinale, Sophia........E. polygoni.
Sium erectum, *latifolium........E. polygoni.
*Smyrnium Olusatrum........ "
Solanum Carolinense........E. cichoracearum.
Solidago Canadensis, *Missouriensis, nana, *occidentalis, *rigida, serotina........E. cichoracearum.
Sonchus arvensis........ "
* " " ....E. polygoni.
S. asper, oleraceus........E. cichoracearum.
*Spartium junceum........E. polygoni.
Spiraea Aruncus........S. humuli.
S. betulifolia........P. oxyacanthae.
S. Camtschatica........S. humuli.
*S. discolor........P. oxyacanthae.
S. Douglasii........P. oxyacanthae var. tridactyla.
*S. Filipendula........S. "Castagnei."
S. salicifolia........P. oxyacanthae.
* " Thunbergii........S. humuli.
S. tomentosa........P. oxyacanthae.
S. Ulmaria........E. polygoni and S. humuli.
Stachys alpina, aspera and vars. *glabra and Japonica, ciliata and var. pubens, *cordata, Germanica, melissaefolia, palustris........E. galeopsidis.
*S. palustris........E. cichoracearum.
S. sylvatica........E. galeopsidis.
Statice Gmelini, Limonium........E. polygoni.
Stevia sp........E. cichoracearum.
Symphoricarpos occidentalis, orbiculatus, racemosus and var. *pauciflorus........M. diffusa.
Symphytum officinale........E. cichoracearum.
* " " ....E. polygoni.
S. tuberosum........E. cichoracearum.
Syringa Amurensis var. Japonica, *Persica, vulgaris........M. alni.
*S. vulgaris........M. alni var. lonicerae.
* " ....P. corylea.
Tanacetum vulgare........E. cichoracearum and P. corylea.
Taraxacum montanum........E. taurica.

T. officinale	S. humuli var. fuliginea.
* "	E. cichoracearum.
Tecoma radicans	M. alni.
* " "	E. cichoracearum.
Tellima grandiflora	S. humuli var. fuliginea.
Teucrium Canadense	E. galeopsidis.
* " "	E. cichoracearum.
T. Chamaedrys	E. taurica.
* "	E. cichoracearum.
* "	E. polygoni.
Thalictrum alpinum	S. humuli var. fuliginea.
T. *angustifolium, aquilegiifolium, Cornuti, flavum, minus and var. elatum, simplex	E. polygoni.
*T. simplex	S. "Castagnei."
*Thelesperma filifolium	"
Thermopsis montana	E. polygoni.
Thesium *bavarum, *ebracteatum	"
*Thevenotia scabra	E. taurica.
*Thlaspi arvense	E. polygoni.
Thymelaea sp	E. taurica.
Tilia Americana	U. Clintonii.
*Tragopogon sp	E. polygoni.
T. porrifolius, pratensis	E. cichoracearum.
*Trifolium sp	S. "Castagnei."
T. *agrarium, alpestre, arvense, filiforme, hybridum, incarnatum, involucratum, longipes, Lupinaster, medium, *minus, *monanthum, montanum, moranthum, pauciflorum, pratense, procumbens, *repens, rubens	E. polygoni.
*Trigonella sp	E. cichoracearum.
T. Cretica, Foenum-graecum	E. polygoni.
Triticum sativum, Spelta, vulgare	E. graminis.
Trollius Europaeus	E. polygoni.
Troximon glaucum, *officinalis	S. humuli var. fuliginea.
*Typha latifolia	P. corylea.
Ulmus alata	U. macrospora and P. corylea.
U. Americana	M. macrospora, P. corylea, and M. alni.
U. campestris	U. clandestina and P. corylea.
U. fulva	U. macrospora.
U. montana	U. clandestina and P. corylea.
*Urtica sp	S. "Castagnei."
U. cannabina, dioica, *urens	E. polygoni.
Vaccinium Canadense	M. alni var. vaccinii.
V. corymbosum	M. alni.
V. *intermedium, Myrtillus	P. oxyacanthae.
V. Myrtillus vars. macrophyllum and *microphyllum, Pennsylvanicum	M. alni var. vaccinii.

V. stamineum...P. corylea.
V. uliginosum...P. oxyacanthae.
V. vacillans...M. alni var. vaccinii.
*Valeriana capitata...E. polygoni.
V. officinalis...E. cichoracearum.
* " ....E. polygoni.
Valerianella *dentata, *rimosa...E. polygoni.
Verbascum Blattaria...E. taurica.
V. nigrum...E. cichoracearum.
V. phlomoides...E. taurica.
* " ....E. polygoni.
* " *pulverulentum...E. cichoracearum.
V. speciosum...E. taurica.
V. *thapsiforme, *Thapsus...E. cichoracearum.
*V. Thapsus...E. polygoni.
Verbena sp...S. humuli var. fuliginea.
V. angustifolia, Aubletia, *bracteata, hastata...E. cichoracearum.
V. hybrida...M. ferruginea.
V. laevis, *officinalis, stricta, urticifolia...E. cichoracearum.
*V. urticifolia...E. galeopsidis.
* " ....E. polygoni.
Verbesina *encelioides, *occidentalis...E. cichoracearum.
Vernonia Baldwini, fasciculata, Noveboracensis... "
*V. Noveboracensis...S. humuli var. fuliginea.
Veronica longifolia, spicata... " "
*V. Teucrium...E. polygoni.
V. Virginica...S. humuli var. fuliginea.
Viburnum acerifolium, dentatum, Lantana, Lentago, Opulus,
prunifolium, pubescens, *Tinus...M. alni.
*Vicia sp...M. diffusa.
V. Americana and var. linearis...M. alni and var. ludens.
V. *Americana and var. *ludens...E. polygoni.
V. Americana var. truncata...M. alni var. ludens.
V. cassubica...M. Bäumleri.
V. *cassubica, Cracca, *Faba, *gemella, *hirsuta, oroboides,
pallida, *sativa, sepium, sylvatica...E. polygoni.
V. sylvatica...M. Bäumleri.
V. tenuifolia...E. taurica.
V. unijuga...E. polygoni.
*Vincetoxicum officinale... "
Viola Canadensis, canina var. sylvestris...S. humuli.
*V. cucullata...S. humuli var. fuliginea.
Vitis *aestivalis, *Californica, *cordifolia, flexuosa, hederacea,
Labrusca and var. Catawba...U. necator.
*V. Labrusca...P. corylea.
V. *riparia, *rupestris, vinifera...U. necator.
*V. vinifera...S. "Castagnei."
Xanthium Canadense...S. humuli var. fuliginea
and E. cichoracearum.

X. Italicum, macrocarpum, spinosum, strumarium...............S. humuli var. fuliginea.
X. strumarium ....E. cichoracearum.
Xanthoxylum Americanum ....P. corylea.
Zelkova acuminata...U. Clintonii and M. alni.
Zygophyllum Fabago ....E. taurica.

ERRATA.

Page 8, line 21, for "a basal," read "an apical."

Page 8, line 22, for "in the first place," read "subsequently."

Page 8, line 7 from bottom, insert comma after "shape," and for "occurs" read "occur."

Page 10, line 6, insert comma after "conidiophores."

Page 23, lines 17, 18, for "*Coumbiana*" read "*Columbiana.*"

Page 27, line 5, insert comma after "interest"; line 18, insert comma after "notes," and delete comma at end of line; line 25, for "Ott's" read "Otth's"; line 36, for "Prof. A. Macacsy Diete" read "Prof. A. Magacsy Dietz."

Page 31, lines 9, 11, 12, for "*penicellata*" read "*penicillata*"; line 16, for "Enun" read "Fenn."

Page 32, line 31, read comma after "species."

Page 33, line 20, insert comma after "distinct," and "of" after "most."

Page 34, line 2 from bottom, for "periitheciis" read "peritheciis."

Page 36, line 18, for "Win." read "Wint."; line 22, for "Ouden." read "Oudem."; line 31, for "Brit." read "Bri."

Page 38, line 6, insert comma after "been."

Page 48, line 5, for "Roumig" read "Roumeg."

Page 49, line 4 from bottom, for "Ontaria" read "Ontario."

Page 50, line 8 from bottom, insert "Sacc." before "Syll. Fung."

Page 52, line 9, for "Hortm." read "Hartm."

Page 53, line 3, for "Cacatiastrum" read "Cacaliastrum."

Page 54, line 8, read comma after "species"; line 9 from bottom, delete comma after "measure"; line 6 from bottom, insert comma after "indicated," and carry parenthesis to end of sentence.

Page 55, line 2, for "largely" read "larger."

Page 56, line 14, for "fulginea" read "fuliginea"; line 10 from bottom, for "o" read "of."

Page 57, line 12 from bottom, for "aber" read "über" and for "art" read "Art."

Page 61, line 19, for "Verwandlschaft" read "Verwandtschaft"; line 7 from bottom, for "Auschauung" read "Anschauung"; line 5 from bottom, for "auftren" read "auftreten."

Page 62, line 3, for "shown on a house plant" read "sown on a host-plant";

Page 63, line 18, for "imperfect" read "infected."

Page 68, line 7, for "weil" read "weit"; line 15, for "nich" read "nicht"; line 21, insert "from" after "suffer."

Page 71, line 16 from bottom, for "Treub." read "Trent."

Page 79, line 15 from bottom, for "unattached" read "unattacked."

Page 84, line 18 from bottom, for "on *U. salicis*" read "of," etc.

Page 87, line 13, for "Oestergren" read "Vestergren."

Page 95, line 4 from bottom, for "Erw." read "Env."

Page 97, line 15, for "Le" read "Se."

Page 103, line 25, for "probably" read "possibly."
Page 103, line 28, for "attached" read "attacked."
Page 103, line 30, delete comma at end of line.
Page 103, line 31, for "or" read "of."
Page 108, line 20, for "or" read "on."
Page 109, line 13, for "forms" read "form."
Page 109, line 25, for "perisistent" read "persistent."
Page 117, line 1, delete comma after "*Uncinula*" and insert comma after "priority."
Page 117, line 18, for "grisecenti" read "grisescenti."
Page 117, line 24, delete comma after "gradatim."
Page 120, line 18, for "equally" read "equalling."
Page 121, line 3 from bottom, for "*E. communis*" read "*E. polygoni.*"
Page 122, line 4, insert "examined" after "specimens."
Page 123, line 16, insert comma after "branches."
Page 123, line 18, insert "with" after "apex."
Page 125, line 20, for "or" read "of."
Page 127, line 23, for "&" read "G."
Page 128, line 24, insert "to" after "related."
Page 135, line 8, replace semicolon after "*Microsphaera*" by comma.
Page 136, line 12 from bottom, for "indefinite" read "in definite."
Page 138, line 3 from bottom, for "fairly" read "faintly."
Page 139, line 10, insert "form" after "another."
Page 141, line 4, after "species" read "and observes of the plant."
Page 141, line 11, for "tips fill" read "tip fills."
Page 143, line 4 from bottom, for "Weerl" read "Neerl."
Page 148, line 6, for "*exclusa*" read "*extensa.*"
Page 148, line 11, insert comma after "*alni.*"
Page 150, line 10 from bottom, for "*E.*" read "*V.*"
Page 152, line 14, delete comma after "diameter."
Page 153, after line 8, insert synonymy and description of var. *calocladophora* (Atkins.) given at page 153, last three lines, and page 154, lines 1–10.
Page 158, line 9, delete comma after "half."
Page 160, line 2 from bottom, for "uses" read "use."
Page 162, line 24, for "possess" read "possesses."
Page 162, lines 29–30, for "necessay" read "necessary."
Page 164, last line, for "lips" read "tips."
Page 166, line 10, for "sightly" read "slightly."
Page 168, line 9 from bottom, for "3–2" read "3–5."
Page 170, line 5, for "seil" read "seit"; line 7, for "aufangs" read "anfangs"; line 17, for "un" read "im"; line 18, for "weinger" read "weniger"; line 20, for, "*P. Bäumleri*" read "*M. Bäumleri.*"
Page 171, line 6 from bottom, for "is" read "ist."
Page 172, line 8, for "*Mäumleri*" and "*Barchica*" read "*Bäumleri*" and "*Marchica.*"
Page 179, line 11, for "*glycyphyllosus*" read "*glycyphyllos*"; line 24, for "*yezoeüsis*" read "*yezoensis.*"
Page 180, line 14, for "*Nessolia*" read "*Nissolia.*"
Page 181, line 7, for "*Sseiie*" read "*Seseli.*"

Page 187, line 3, for "of" read "on"; line 5, delete comma after "*vernalis.*"
Page 192, line 21, insert "which" after "spores."
Page 195, line 7, for "knantiae" read "knautiae."
Page 204, line 10 from bottom, for "Passinini" read "Passerini."
Page 215, last line, for "*Erisyphe*" read "*Erysiphe.*"
Page 217, line 5, for "*Carinthe*" read "*Cerinthe*"; line 8, for "*Dorycinum*" read "*Dorycnium.*"
Page 225, line 7, for "*orbiculatus*" read "*orbicularis.*"
Page 233, line 2, insert "the" before "*Phyllactinia.*"
Page 234, line 6 from bottom, insert comma after "outgrowths."
Page 235, line 5, delete "again."
Page 236, line 15, for "soul" read "sont"; line 7 from bottom, insert period after "A."
Page 237, line 11, for "*radiens*" read "*radians*"; line 7 from bottom for "dout" read "dont."
Page 244, no. 77, for "Calmeiro" read "Colmeiro."
Page 246, no. 106, for "Hayl" read "Haye"; no. 111, for "Mycelogensi" read "Mycetogenesi"; no. 125, delete "Part 3."
Page 248, no. 160, for "*Sphraeo-*" read "*Sphaero-.*"
Page 250, last line, for "1858," read "1851."
Page 251, no. 222, for "17—," read "1769."
Page 252, no. 237, for "Malphigia" read "Malpighia."
Page 256, no. 321, for "Shumacher" read "Schumacher."
Page 258, no. 369, for "Nauv." read "Nouv."
Page 259, no. 384, for "Wetteranisch." read "Wetterauisch."
Page 262, line 11 from bottom, for "hausterium" read "haustorium."
Page 264, line 1, for "*oplhantha*" read "*lophantha.*"
Page 266, line 20, for "*corleay*" read "*corylea.*"
Page 272, last line, insert "see page 112."

Note.—The numbers occurring in the geographical distribution, and following certain host-plants, refer to published records, which will be found in the works of authors quoted under the respective number in the Bibliography; in all other cases, the occurrence of the species on the host-plants given, and its geographical distribution, have been personally verified.

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